United States
Department of
Agriculture

Marketing and
Regulatory
Programs

Animal and
Plant Health
Inspection
Service

Carcass Management During a Mass Animal Health Emergency

Draft Programmatic Environmental Impact Statement—August 2015

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Executive Summary

The mission of U.S. Department of Agriculture (USDA)–Animal and Plant Health Inspection Service (APHIS)–Veterinary Services (VS) is to protect and improve the health, quality, and marketability of U.S. animals and animal products by preventing, controlling, and/or eliminating animal diseases. It is within APHIS' mission to protect U.S. agriculture and natural resources, while ensuring public health and safety.

Livestock carcasses in large numbers can present a potential environmental hazard. There is a need to effectively manage carcasses in a mass animal health emergency to reduce potential risks to humans, livestock, and the surrounding environment. As carcasses begin to degrade, bodily fluids, naturally and unnaturally occurring chemical, biological, and radiological leachate components, and hazardous gases may be released into the environment, potentially impacting the health and safety of surrounding humans, livestock, and wildlife. In addition, the processes used to manage the carcasses may result in air emissions, liquid effluent, and/or solid byproducts which may pose a risk to human health, animal health, and the environment.

In this programmatic environmental impact statement (EIS), APHIS analyzes the environmental effects associated with various carcass management alternatives that could be implemented during a mass animal health emergency (defined in this document to be a natural disaster or a biological, chemical, and/or radiological event generating 50 tons of carcasses or more). The purpose of the alternatives is to enhance emergency preparedness, and to allow for greater use of improved carcass management options in addition to the traditional methods of unlined burial and open-air burning during mass animal health emergencies.

The findings of this programmatic EIS will be used to support mass animal health emergency planning and decisionmaking. Considering the environmental effects of various carcass management options that may be used during an emergency gives the decisionmakers enhanced ability to protect the environment, minimize delays, and save resources. In addition, when there is a mass animal health emergency requiring immediate action, APHIS may use information presented in this EIS to promptly fulfill its National Environmental Policy Act (NEPA) obligations. Lastly, this EIS informs the public about the potential environmental effects of currently available carcass management options, as well as obtains comments from the public regarding the various options and potential impacts.

This EIS considers three proposed alternatives for the management of carcasses during a mass animal health emergency, including:

- **No Action Alternative**

Under the no action alternative, APHIS would continue to manage carcasses in a mass animal health emergency, using either unlined burial or open-air burning. Unlined burial and open-air burning typically occur on the premises of the mass animal health emergency.

- **Standard Procedures Alternative**

Under the standard procedures alternative, four additional carcass management options would be considered, along with those listed in the no action alternative. Under this alternative, management options include unlined burial, open-air burning, composting, rendering, landfills compliant with the Resource, Conservation, and Recovery Act (RCRA), and/or fixed-facility incineration compliant with the Clean Air Act (CAA). Rendering, landfills, and fixed-facility incineration would occur offsite. Composting would typically take place onsite. Each of the management options may be used separately or in combination with another option.

- **Adaptive Management Alternative (Preferred Alternative)**

The adaptive management alternative allows for all available carcass management options to be considered and potentially used during a mass animal health emergency. This alternative is expected to provide greater flexibility for using the best available resources in such an event. This alternative includes management options from the no action alternative (i.e., unlined burial and open-air burning), any additional options within the standard procedures alternative (composting, rendering, landfills compliant with RCRA, and/or fixed-facility incineration compliant with CAA), and any other disposal options that would pose equal or fewer environmental impacts. Carcass management options would be used either singly or in combination with each other.

Potential Environmental Impacts

- **No Action Alternative**

Unlined burial and open-air burning of carcasses during a mass animal health emergency are expected to have the greatest impacts to the environment, particularly when carcasses are contaminated with biological, chemical, and/or radiological agents not naturally found in animal carcasses. These two carcass management options must only be used after carefully weighing risk factors. Soil and water quality will primarily be impacted by carcass leachate, particle deposition, and excess combustion fuel. Air quality has the potential to be impacted by the emissions from combustion, as well as gas generated from decomposition during landfill and burial. Humans and other animals may, in turn, be exposed to these soil, water, and air contaminants. The potential for adverse impacts to humans and other animals is increased if carcasses contain unnaturally occurring biological, chemical, and/or radiological agents, as well as those agents that are not completely inactivated, diluted, or degraded.

- **Standard Procedures Alternative**

Carcass management options under the standard procedures alternative (landfill, rendering, incineration and composting) generally are expected to have less environmental impacts than the no action options (open-air burning and unlined burial). Impacts to soil, air, and water are expected to be minimized by handling carcasses at regulated facilities (i.e., rendering facilities, fixed-facility incinerators, and landfills). Byproducts of degrading carcasses, such as leachate (potentially containing biological, chemical, and/or radiological agents, depending on the type of animal health incident) and gases, are better contained within these controlled facilities than with those methods under the no action alternative. More controlled processing within regulated facilities (e.g., incinerators) is generally better able to destroy disease agents, and destroy or capture potentially toxic residues and byproducts. With the enhanced containment and processing procedures, risk to humans and other animals are reduced. While composting is effective at degrading many disease agents, the process may not be as well contained as the other management options in the standard procedures alternative, therefore, harmful byproducts can move into the environment unless containment measures are employed. Composting must always be performed in a controlled manner by certified personnel.

- **Adaptive Management Alternative (Preferred Alternative)**

The adaptive management alternative provides the greatest flexibility in carcass management. Program decisionmakers could potentially use any carcass management technologies present at or near the location of the mass animal health emergency, with a preference for standard procedures (landfill, rendering, incineration and composting) over no action procedures (open-air burning and unlined burial). This alternative also allows the use of nonstandard options such as alkaline hydrolysis, anaerobic digestion, microwave sterilization, and gasification, to name a few. The potential environmental impacts of any nonstandard options will be analyzed just before the time of use and within a separate risk assessment, and then considered and discussed within a site-specific environmental assessment (EA). If the risk assessment indicates that the risks to human health and the environment are equal to, or fewer than, the risks identified in the no action or standard procedures alternatives, the nonstandard option may be used.

APHIS recognizes that the use of nonstandard options in a mass animal health emergency would be rare, if at all. In addition, it is impossible to consider all nonstandard technologies that currently exist or will exist in the future. The technologies for these nonstandard options have several logistical issues to overcome before APHIS could consider their use. To date, nonstandard options are not capable of managing large numbers of carcasses, either because the technologies have low capacity or there simply are not enough units (e.g., anaerobic digesters) available. However, should there be a change in the efficiency, number, or geographic range of nonstandard technologies, it is imperative that decisionsmakers have the ability to quickly identify these carcass management options, analyze resulting risks, and implement the chosen course of action for their use.

The decision to use any method in a mass animal health emergency must be made in a timely and effective manner. Handling of the carcasses, under such circumstances, requires removal and transport from the field prior to advanced stages of decomposition. The tiering of site-specific EAs to this programmatic EIS allows the mass animal health emergency program to summarize and cite the potential impacts of the carcass management methods, and then proceed with the action during the comment period for the site-specific environmental assessment. This ensures that program actions can minimize release of biological, chemical, and/or radiological agents, as well as minimize environmental risks. This benefits the program, as well as any individuals and organizations having to cope with those local public or veterinary health concerns associated with mass animal carcass management. The advanced planning information regarding potential environmental impacts in this EIS provides important input to the decisionmaker before selecting a specific course of action (e.g., immediate depopulation) when such mass animal health emergencies occur.

I. Purpose and Need

The U.S. Department of Agriculture (USDA)–Animal and Plant Health Inspection ervice (APHIS)–Veterinary Services (VS) is considering and comparing various alternatives for the management of animal carcasses during a mass animal health emergency for the purpose of emergency preparedness and consistency with the Animal Health Protection Act (AHPA) as amended (7 United States Code (U.S.C.) §§ 8301–8317). This environmental impact statement (EIS) provides the decisionmaker with analyses of potential environmental impacts of different alternatives so an informed decision can be made. Included in this chapter are the background and the basis for the action being proposed by VS, as well as:

- an explanation of carcass management terms used within this EIS;
- the purpose and need for considering and comparing alternative carcass management methods;
- the scope or range of issues that this EIS will cover;
- a discussion of public involvment in the EIS process; and
- an explanation of the jurisdictional issues surrounding carcass management.

This chapter provides a context for the later chapters regarding the proposed alternative actions and their potential environmental consequences.

For purposes of this document, carcass refers to the bodies or body parts of dead livestock. USDA defines livestock as all farm-raised animals (7 U.S.C. § 8302(10)). Carcasses are often combined with manure, bedding, and other organic materials that are difficult to separate from the dead animal remains.

Carcass management refers to the location, collection, transportation, processing/treatment, and/or disposal of carcasses and body parts, as well as the cleanup and decontamination after the carcasses are removed from the site. Disposal of the carcasses refers to either the placement of a carcass in its final location, or to the treatment and/or processing of the carcasses.

Carcass management during a mass animal health emergency specifically refers to managing carcasses during the sudden death of many animals within a small area during a short period of time. A mass animal health emergency typically arises from an outbreak of a foreign animal disease

(FAD) (e.g., foot-and-mouth disease (FMD) in cattle) or a natural disaster (e.g., massive flooding, earthquake, hurricane, or tornado), however, could also result from the accidental or intentional (as an act of terrorism) introduction of a biological, chemical, or radiological agent. FADs are high-consequence diseases that are usually nonexistent in the United States or limited in distribution.

Carcass management, during a mass animal health emergency, entails overlapping and cooperative efforts from multiple authorities and/or stakeholders (e.g., Federal Government, State government, local government, and livestock producers). Carcass management may focus on the cause of death (e.g., euthanasia, natural disaster, or biological, chemical, and/or radiological agent), the environment and surrounding human resources, and any change in the management of animals (e.g., redirect livestock grazing, manage wildlife). Carcass management should involve careful surveillance of carcass discovery sites, carcass collection sites, disease detection sites, livestock and wildlife populations (both onsite and offsite), transport sites, disposal sites, buffer zones (i.e., areas surrounding the carcass management site), equipment and personnel, weather conditions (e.g., wind direction and speed), ground settling, ground water monitoring, residue and waste product testing, local wildlife, odor, and noise monitoring (Mukhtar et al., 2012).

A. Purpose and Need for Alternative Actions

There is a need for APHIS to effectively manage livestock carcasses in a mass animal health emergency to reduce potential risks to humans, animal, and environmental health. The purpose of the carcass management alternatives is to allow for greater use of improved carcass management options. Improved options may include landfill, rendering, incineration, composting, and non-standard methods, rather than the traditional options of unlined burial and open-air burning. The proposed alternatives will enhance emergency preparedness and consistency with the Animal Health Protection Act (AHPA). In general, once carcasses are collected, regulating agencies then make decisions regarding the management methods; this response process needs to be modified. Potential carcass management plans must be considered in advance of large-scale incidents.

It is within APHIS' mission to protect U.S. agriculture and natural resources, while contributing to efforts to ensure public health and safety. By considering the environmental effects of various carcass management options in advance of an emergency, decisionmakers will be better able to respond effectively to the mass animal health emergency while protecting human health, animal health, and the environment.

Effective carcass management is necessary because carcasses, in sufficient numbers, can present a potential environmental and public health hazard.

As carcasses begin to degrade, bodily fluids, chemical and biological leachate (the liquid that results from decomposition of the biomass and includes bodily fluids that leak from the dead animal) components, and hazardous gases (e.g., methane) are released into the environment, potentially impacting the health and safety of surrounding humans, presumably healthy livestock, and wildlife. Carcasses also may:

- transmit biological, chemical, and/or radiological agents to susceptible humans and other animals, depending on the cause of the emergency;
- attract undesirable scavengers;
- affect how surrounding herds are managed;
- cause public concern;
- damage owner and industry reputations; and
- disrupt the flow of commerce.

The risk of environmental effects increases as the number of carcasses in a given area increases. When livestock die due to causes such as old age or accidents, deaths vary in time and location. These carcasses are routinely managed by livestock producers. However, during a mass animal health emergency, such as during a disease outbreak or natural disaster, there are suddenly many carcasses to manage at the same time. Additional carcasses may be generated from subsequently euthanized livestock. Therefore, the risk of environmental effects depends on the number of carcasses in combination with various other factors, such as the location of the deaths, the cause of deaths, and the substances that may be released from the carcasses as they degrade.

Effective carcass management (including locating and managing the carcasses quickly) will minimize the spread of disease, protect human health and the environment, and conserve meat or animal protein for consumption if biosecurity (procedures that are intended to protect humans or animals against diseases or other harmful agents) is not compromised (HHS, 2005). Carcass management may also contain the spread of chemical and radiological agents. If animals must be euthanized during the emergency response, the euthanasia method (e.g., lead bullets, drugs) must be considered in the carcass management plan to ensure any potential additional environmental impacts from such actions are minimized. Ideally, carcass management uses the safest, most timely, environmentally responsible, and cost-effective methods available. When these methods lead to conflicting choices, effective carcass management develops the best possible management plan. Improper carcass management extends the potential for additional livestock deaths, ongoing environmental cleanups, public controversy, and the potential for future legal liability.

Internationally, a well-devised carcass management plan is viewed as a key component of a country's ability to recover from an animal disease outbreak. As a member of the World Organization for Animal Health (OIE), the U.S. status for communicable diseases (diseases transferred from one animal to another e.g., bovine spongiform encephalopathy (BSE), contagious bovine pleuropneumonia (CBPP), rinderpest, and FMD) are tracked and reported (OIE, 2015a). Effective carcass management within the United States during a FAD outbreak is essential to ensure normal international trade relations.

B. Mass Animal Health Emergency Scenarios

The majority of mass animal health emergencies occur from natural disasters or disease outbreaks. In addition, severe weather events in major livestock production areas may result in the death of many thousands of animals. For example, in South Dakota, in October 2013, approximately 30,000 head of cattle died during a rapid 10-ft-blizzard snowfall, followed by a rapid thaw. Ranch owners and responders had difficulty finding the carcasses. Once the carcasses were found, it was very difficult to access and manage the situation because the sodden soils could not support the necessary machinery. The carcasses had decomposed causing strong odors, attracting scavengers, and leaching fluids into the soil.

Rendering and composting are the usual disposal options for routine mortalities; however, a large number of carcasses in a short time can exceed the capacity of routine management processes. Landfilling is another option, however many landfills cannot handle the volume, are not equipped to manage a large quantity of carcass leachate, or are simply unwilling to accept the material. Fixed-facility incineration is an option; however, the United States has little excess incineration capacity, and incinerators are often not permitted to accept carcasses. Because carcasses contain over 60 percent water, this method is slow, expensive, and also requires the carcasses to be transported to the facility. Transportation can be another complicating factor, depending on the distance from the affected area to the disposal facility. Portable incinerators that can be moved to the property are generally limited to small batch capacities. Only a few States (e.g., California, Idaho, and Texas) allow natural decomposition unless there is an emergency. Handling partially decomposed carcasses present additional challenges.

Many people advocate composting carcasses because it is a natural process producing beneficial soil amendments (a product that can be added to the soil to improve its physical qualities and aid in nutrient availability for plants). Composting, however, requires at least 2 pounds of carbon source (e.g., wood chips) for each pound of carcass, and removes large areas of land from use for up to a year. The carcasses could be burned on an affected premise; however, that requires a great deal of wood or other fuel, and produces large plumes of thick smoke. Depending on the time of the year, there may be bans on burning in an area. Ultimately, as in the case of the 2013 blizzard in South Dakota, many people decided to bury the carcasses in unlined pits or trenches. This practice may lead to contamination of drinking water from leachate infiltrating the water supply if the necessary mitigations are not implemented.

Biological, chemical, and radiological exposures present additional environmental hazards during carcass management. For example, a recent European emergency involved accidental contamination of animal feed with dioxin, a highly toxic and persistent chemical. The exposed livestock were no longer suitable for consumption and were euthanized. Dioxin-containing carcasses may be classified as hazardous waste resulting in extremely high disposal costs because standard disposal facilities cannot receive or process hazardous waste. While composting may degrade some toxins, other toxins persist after composting. Burning or burial could spread contamination via smoke and/or leachate. The challenges of managing radiologically contaminated carcasses depend on the level of radioactivity and the half-life (the amount of time required for a quantity of a specific radioactive element to decay by half) of the offending radioactive particles. Managing radiologically contaminated animal carcasses would be similar to or exceed those challenges presented by chemically contaminated carcasses.

In comparison, animal mortalities resulting from an infectious agent (e.g., FMD virus (FMDv) or avian influenza viruses (AIv)) pose management challenges associated with preventing pathogen (a bacterium, virus, or other micro-organism that can cause disease) spread. Rendering and incineration facilities need to be sanitized prior to resuming normal operations, which can prove difficult. Although rendering would likely inactivate most pathogens, it is difficult to prove pathogens of concern (due to impacts to humans or other animals) have been inactivated. Similarly, incinerators could be difficult to sanitize, may be limited in ability to hold a large number of carcasses, and may require that the size of the carcasses be reduced in order to fit into the unit. Composting could inactivate many pathogens; however, the byproducts may not be suitable for use as a soil amendment due to potential contamination from pathogens that remain viable. Open-air burning may cause air transport of infectious particles. There also may be difficulty in delivering the fuel needed for open-air burning to the emergency site. Unlined burial can contaminate ground water, as was the case during the South Korean FMD outbreak in 2010 and 2011. The severity of risk of ground water contamination from leachate resulting from unlined burials depends on the soil characteristics in the area.

In all of the above mentioned situations, facility workers, nearby residents, and other stakeholders may raise concerns regarding impacts to human health and the environment. These issues create a dilemma during emergencies as decisionmakers attempt to cope with site-specific environmental limitations.

C. Purpose of this Environmental Impact Statement

The findings of this EIS will be used for planning and decisionmaking during mass animal health emergencies. In addition, when there is a mass animal health emergency requiring immediate action and mass carcass management options are deployed, APHIS may use information presented in this EIS to promptly fulfill its National Environmental Policy Act (NEPA) obligations. Lastly, this EIS will be used to inform the public about the potential environmental effects of currently available carcass management options, as well as obtain their comments regarding the various options and potential impacts.

As part of obtaining public feedback on this EIS, on October 25, 2013, a notice of intent (NOI) to prepare a programmatic EIS on carcass management options was published in the *Federal Register* (FR). Subsequently, announcement of the NOI was posted on APHIS' stakeholder registry (APHIS, n.d.–1 at https://public.govdelivery.com/accounts/USDAAPHIS/subscriber/new) and emails were sent directly to certain stakeholders, including regulatory agencies, waste management industries, and small/minority farmers.

The comment period for the NOI was initially for 30 days, but was extended for a total of 90 days. A total of 13 formal written comments were received; of those 13 comments, there were 3 commenters that were in support of the EIS. The other 10 commenters expressed neither support nor opposition of the EIS, however, expressed concerns regarding the subjects that would be addressed.

- 5 commenters discussed specific carcass management methods each would like to see considered in the document;
- 5 commenters presented potential environmental and economic impacts they would like to see discussed and/or how those impacts should be presented in the document;
- 5 commenters provided literature they believed should be reviewed to write the EIS;

- 3 commenters stressed that carcass management options should be flexible and allow for State input; and

- 1 commenter expressed concern for the protection of threatened and endangered (T&E) species.

In June 2013, letters were sent to the federally recognized Native American tribes informing them that USDA–APHIS intended to prepare a programmatic EIS to analyze the potential environmental impacts related to various carcass management options. The letter also informed the tribes of a teleconference to be held at the end of the month, and provided necessary call-in information and staff contact information. APHIS' teleconference with tribes was held at the end of June 2013. Numerous tribes participated in the teleconference and discussed their concerns with the agency. There were subsequent letters, emails, and telephone calls from the tribes to which APHIS responded directly. Information regarding the EIS process was posted on APHIS' Web site designated for tribal relations (APHIS, n.d.–2.) Comments obtained during the scoping period influenced the scope and analysis of this EIS. (See chapter 4 under the section titled, Executive Order (EO) 13175, "Indian Tribal Consultation and Coordination" for additional information.)

D. Scope of this Environmental Impact Statement

As a Federal Government agency subject to compliance with NEPA (42 U.S.C. §§ 4321–4347), APHIS prepared this EIS in accordance with the applicable implementing and administrative regulations (40 CFR §§ 1500–1508; 7 CFR §§1b, 2.22(a)(8), 2.80(a)(30), 371.4, and 372). This document will analyze the potential environmental effects caused by using various carcass management options during a mass animal health emergency. The alternatives will include large-scale and readily available mass carcass management options.

While carcass management refers to the location, collection, transportation, processing/treatment, and/or disposal of dead animals and body parts, as well as cleanup and decontamination of the site after carcasses are removed, the potential environmental impacts are expected primarily from the processing/treatment and/or disposal of carcasses and the subsequent byproducts. Therefore, this EIS will focus primarily on the environmental effects of the various management options (open burning, unlined burial, landfill, rendering, incineration, composting, and nonstandard options). However, additional aspects of carcass management (i.e., transportation of carcasses and decontamination) will be reviewed. The effects of the causes of death (i.e., natural disaster; livestock disease; or chemical and radiological agents) will also be considered. Because so many variables will be considered, scenarios determined to be the most likely to occur will have more consideration in this document.

In general, State and local authorities do not quantify the number of carcasses that would amount to “mass” carcass management. For purposes of this EIS, APHIS is considering mass carcass management to be the management of 50 tons (100,000 pounds) or more of biomass per premises (where livestock are housed or kept) within a limited amount of time (approximately 1 day to several weeks). For example, 100 beef cattle each weighing approximately 1,000 pounds would meet the threshold for consideration under this EIS. APHIS intends to use this threshold to limit the scope of this EIS.

E. Authority to Take Action

The mission of APHIS–VS is to protect and improve the health, quality, and marketability of U.S. animals, animal products, and veterinary biologics by preventing, controlling, and/or eliminating animal diseases. VS derives its mission from the AHPA as amended (7 U.S.C. §§ 8301–8317). AHPA authorizes the Secretary of Agriculture to hold, seize, quarantine, treat, destroy, and dispose of animals entering the country, or moving in interstate commerce that carries, are affected with, or are exposed to livestock pests or diseases (7 U.S.C. § 8306(a)). Extraordinary emergencies authorize the Secretary to, “hold, seize, treat, apply other remedial actions to, destroy (including preventative slaughter), or otherwise dispose of, any animal, article, facility, or means of conveyance to prevent pest or disease dissemination” (7 U.S.C. § 8306(b)).

Federal actions during an extraordinary emergency within a State occur only when there is a finding that “. . . measures being taken by the State are inadequate to control or eradicate the pest or disease,” (7 U.S.C. § 8306(b)(2)(A)). In these situations, carcass management may occur in a State after review and consultation with the Governor, or an appropriate animal health official of the State, or the head of a Native American tribe (7 U.S.C. § 8306(b)(2)). Even when the State or a tribe retains the lead in a mass animal health emergency, APHIS can coordinate transportation and disposal of contaminated or potentially contaminated animal carcasses.

APHIS’ authority to manage carcasses during a mass animal health emergency can overlap with the authority of other Federal agencies. In addition to AHPA, there are other acts and subsequent regulations that relate to routine carcass management activities and emergency planning. Combined, these acts and regulations create a network of potential responders from a variety of Federal agencies during a mass animal health emergency.

Current APHIS regulations for FMD, pleuropneumonia, rinderpest, and certain other communicable diseases of livestock, derived from OIE recommendations state ". . . animals infected with or exposed to disease shall be killed promptly after appraisal and disposed of by burial or burning . . ."; however, the APHIS Administrator has the discretion to order the use of other methods (9 CFR § 53.4(a)). This rule applies to communicable diseases of livestock that constitute an emergency and threaten U.S. animals (9 CFR § 53.1). There are a limited number of additional APHIS program regulations that specify the means for carcass management (see table 1–1 below). The regulations do not specifically recognize disposal methods during mass animal health emergencies.

Table 1–1. APHIS' Program-Specific Carcass Management Regulations.

Program	Management Options	Regulation*
Brucellosis	Swine: slaughter, burial, incineration, "or other disposal means authorized by applicable State law"	9 CFR § 51.6
	Goats, sheep, horses: slaughter, burial, incineration, or rendered "in accordance with applicable State law"	9 CFR § 51.29
Hog cholera	Separate slaughter from other livestock	9 CFR § 309.5
Hydatid cysts in liver	Rendering (referred to in regulations as tanking)	9 CFR § 314.10
Poultry with H5/H7 LPAI	Burial, incineration, composting, or rendering under strict biosecurity procedures	9 CFR § 56.5
Trichinae certification	Rendering, incineration, composting, burial, and "disposal by 'other means' that meet prevailing law in an area"	9 CFR § 149.7(a)(1)(i)-(iv)
Tuberculosis eradication	Burial, incinerating, rendering, "or otherwise disposing of infected, exposed, or suspect livestock"	9 CFR § 50.8

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II. Alternatives

The Council on Environmental Quality (CEQ), established by Congress within the Executive Office of the President, works closely with Federal agencies to develop environmental policies and initiatives. NEPA regulations (40 CFR §§ 1500–1508) require Federal agencies to consider in their environmental documentation the no action alternative, proposed actions, and other reasonable alternatives. The no action alternative continues the present course of action, and is used as a benchmark or baseline to compare potential environmental impacts among the alternatives. Reasonable alternatives to the proposed action refer to those options that are technologically and economically practical or feasible.

Prior to initiating this EIS, APHIS considered the use of many carcass management options during a mass animal health emergency. APHIS decided on effective, economically efficient and, primarily, readily available management options. APHIS organized these options into the first two alternatives considered in this EIS. APHIS solicited comments on these potential carcass management options during the public scoping period. Subsequently, a third alternative was identified that could incorporate a variety of nonstandard disposal options that may become more effective, economical, and/or available in the future. The three alternatives considered in this EIS include:

- APHIS would continue to manage carcasses using either unlined burial or open-air burning, as described in 9 CFR § 53.4(a).

- APHIS would add four additional carcass disposal options to those listed in the no action alternative. Under this alternative, unlined burial, open-air burning, composting, offsite rendering, landfill, and/or fixed-facility incineration would be used.

- APHIS would use disposal options listed under the standard procedures alternative (unlined burial, open-air burning, composting, rendering, landfill, and fixed-facility incineration), as well as any other nonstandard options that pose the same or fewer environmental impacts than those associated with the no action and standard procedure alternatives.

A. Description of Alternatives

1. No Action Alternative

Under the no action alternative, APHIS would continue to manage carcasses in a mass animal health emergency using either unlined burial or open-air burning, as described in 9 CFR § 53.4(a). Unlined burial and open-air burning typically occur on the premises of the mass animal health emergency; therefore transportation of carcasses is often limited to the affected premises. Management equipment and materials not already on the property would need to be transported to the premises.

2. Standard Procedures Alternative

Under the standard procedures alternative, four additional carcass disposal options would be considered along with those listed in the no action alternative. Under this alternative, the disposal options include unlined burial, open-air burning, composting, rendering, landfills compliant with the Resource Conservation and Recovery Act (RCRA), and/or fixed-facility incineration compliant with the Clean Air Act (CAA). Unlike the no action alternative, not all of these disposal options would take place on the premises of the mass animal health emergency. Offsite transportation would need to occur for at least three of the disposal options including rendering, landfills, and fixed-facility incineration. If disposal and transportation equipment and materials are not already on a site, they would need to be delivered. Each of the disposal options may be used separately or in combination with another option. Use of a combination of disposal options has the potential to reduce overall response time as long as certain resources, such as trained personnel, are increased.

3. Adaptive Management Alternative (Preferred Alternative)

The adaptive management alternative allows for all available carcass management options to be considered and potentially used during a mass animal health emergency. This alternative is expected to provide greater flexibility for an animal health emergency incident commander or manager to use the best available resources in a mass animal health emergency.

The adaptive management alternative includes disposal options from the no action alternative (i.e., unlined burial and open-air burning), any additional options within the standard procedures alternative (composting, rendering, landfills compliant with RCRA, and/or fixed-facility incineration compliant with the CAA), and any other carcass management options that would pose equal or fewer environmental impacts. Carcass management options would be used either singly or in combination with other carcass management options. To determine whether the nonstandard management options pose equal or fewer environmental impacts, a risk assessment, made available to the public, will be prepared on a case-by-case basis. If the risk assessment demonstrates the nonstandard option poses equal or fewer adverse environmental impacts than the options under the other alternatives, then the animal health emergency manager, or incident commander, may decide to employ the new disposal option without updating or supplementing this EIS.

Other disposal options that could potentially be considered under this alternative include, but are not limited to, alkaline hydrolysis, anaerobic digestion, microwave sterilization, and gasification.

APHIS recognizes the use of these and other nonstandard disposal options in mass animal health emergencies would be rare, if at all. At the present time, these nonstandard options do not have sufficient capacity to process large numbers of carcasses, are not available in many locations, and/or do not have a large number of units available for use at any given location. In certain situations, however, these options, when combined with other management options, may best meet the needs of the mass animal health emergency. Additionally, APHIS anticipates that some of these technologies will increase in efficiency and/or availability over time.

The concept of adaptive management exists within current statutes, regulations, and rules. Adaptive management language in State or territory sources of law generally authorizes the use of "any method" or other methods or technologies under specific circumstances (see Appendix A—Pertinent State Laws on Carcass Management). While these authorizations give some flexibility, approval for a new method generally rests with the commissioner, State veterinarian, or head of the applicable department of agriculture. There may be provisions for immediate adoption of new methods in emergency situations, or a requirement for codification within a departmental rule prior to use.

B. Components of Carcass Management Alternatives

Table 2–1 summarizes the three action alternatives by indicating which carcass management options would be available within each alternative. The various management options are then discussed briefly following the table below. The alternative actions presented in this chapter will be the basis for analyzing potential environmental impacts and possible mitigation measures in chapter 4 of this EIS. Any background information necessary for understanding the potential environmental effects will be presented in chapter 3.

While the use of euthanasia could play a role in determining which carcass management options are used, it is not considered a carcass management option in this document and, therefore, is not discussed further in this chapter. Euthanasia will be discussed in chapters 3 and 4, as it relates to the presence of toxic chemicals within the carcasses.

Table 2–1. Carcass Management Options Considered Under Different Action Alternatives.

Action Alternatives	Carcass Management Options								
	Carcass Disposal Options								
	Unlined Burial	Open-Air Burning	Composting	Rendering	Landfill	Fixed-Facility Incineration	Other Available Disposal Options *	Offsite Transportation	Decontamination
No Action	X	X							X
Standard Procedures	X	X	X	X	X	X		X	X
Adaptive Management	X	X	X	X	X	X	X	X	X

* "Other available disposal options" would only include those options that pose the same or fewer environmental impacts than those associated with the no action and standard procedures alternatives. Examples include, but are not limited to, air-curtain incineration, alkaline hydrolysis, anaerobic digestion, microwave sterilization, and gasification.

1. Disposal Options

a. Unlined Burial

Unlined burial involves excavating a pit in the earth, placing the carcasses in the pit, and backfilling with the excavated material. The action is referred to as trench burial when a long narrow pit (trench) is dug versus a large circular hole. Unlined burial would typically take place at a single, central location on the premises where the mass animal health emergency occurred. However, trench burials may also be constructed with multiple trenches at the affected premises. Carcasses from multiple premises may also be gathered and buried at a single centralized location.

Local authorities should be consulted when using unlined burial. Local laws and codes may apply, and permits may be needed. State requirements also may exist. For example, States vary in their depth and cover requirements for buried carcasses (see appendix A, table A–2).

Figure 2–1. Unlined trench to be used for burying carcasses.
(Source: unknown)

b. Open-Air Burning

During open-air burning, carcasses are placed on combustible heaps known as pyres, in an open field and burned to ash. Open-air burning typically occurs on the affected premises where the mass animal health emergency occurred. As with unlined burial, there may be local laws and codes that would apply to onsite burning, and permits may be required.

Some jurisdictions ban open-air burning during part or all of the year, or require permits. Also, some States ban open-air burning or require a permit (see appendix A, table A–2). Local ordinances and fire restrictions may apply, and recommendations from local sources should be considered. Open-air burning is not appropriate for carcasses contaminated with certain radioactive agents as the process may disperse the agents.

Figure 2–2. Smoke rising from a pyre during open-air burning of livestock (Source: Ledingham, S., n.d.)

c. Composting

Composting is a decomposition process that takes place in the presence of oxygen (or air) and relies on naturally occurring microbes, such as bacteria and fungi, to aid in the process (Auvermann et al., 2006). Carcasses are combined with organic matter either directly on the ground or on a protective barrier that lies on the ground (e.g. plastic or cement). Windrow composting is when the carbon-rich organic matter and carcasses are piled in long rows. Carcass composting can take place on the affected premises of the mass animal health emergency, or at a centralized location away from the affected premises. Offsite transportation efforts may or may not be necessary. Composting must be performed in a controlled manner by certified personnel.

Figure 2–3. Carcass compost piles
(Source: Severidt, J.A. et al., 2002)

d. Rendering

Rendering is a physical and chemical transformation of animal products using a variety of equipment and processes (Meeker, 2009). All rendering processes require the application of heat, the extraction of moisture, and the separation of fat (Meeker, 2009).

The removal of hide and carcass cleaning becomes more difficult when a carcass is in the advanced stages of decomposition (Auvermann, 2004). In addition, raw materials in advanced stages of decay result in poor quality end products. (Auvermann, 2004); therefore, it is preferable that carcasses be sent to a rendering plant while in the early stages of decomposition if the rendered byproducts are to be marketed. The livestock carcasses (raw materials) are ground into consistent particle size and put into a cooking vessel. It is heated with steam to temperatures of 240 to 290 °F for 40 to 90 minutes (depending on the system and materials). The melted fat is then separated from the protein and bone solids with a press, and a large portion of the moisture is removed. Lastly, the protein, minerals, and some residual fat are further processed by additional moisture removal and grinding, and then transferred for storage or shipment (Meeker, 2009). Rendering facilities typically are equipped with scrubbers to control emissions of odors and air toxins, as well as wastewater treatment systems to meet discharge permit requirements for the wastewater that is generated.

Figure 2–4. Both photos above show equipment in a rendering facility. (Source: Anderson, D.P., n.d)

e. Landfills

In the United States, landfills are highly regulated engineered structures that contain solid wastes. Disposal of animal carcasses is allowed in landfills if the facilities have been approved to accept this type of waste. Poultry carcasses were placed in landfills during the 2002 avian influenza outbreak in Virginia, and the 2002 exotic Newcastle disease outbreak in California.

RCRA, as amended (RCRA; 42 U.S.C. § 6901 et seq.; regulations codified at 40 CFR part 258) created standards for the generation, treatment, storage, and disposal of wastes. It essentially banned open dumps (40 CFR §§ 258.1(g), 258.1(h)). EPA is responsible for compliance monitoring and enforcement activities under RCRA.

Figure 2–5. Disposal of carcasses within a landfill.
(Source: unknown)

f. Fixed-Facility Incineration

Incineration is a waste treatment process that ignites waste materials, combusts the organic portion of the materials, and captures the inorganic portion of the materials either as fly ash (or flue-ash, which is a fine particle residue that rises with gases generated during/after combustion) or bottom ash (larger, noncombustible residue that will fall to the bottom of the furnace). Fixed-facility incineration occurs at facilities that are dedicated to this purpose, as opposed to mobile incinerators, which are transported to various sites. Fixed-facility incinerators include small on-farm incinerators, small and large municipal and hazardous waste incineration facilities, crematories, and power plant incinerators. Unlike open-air burning, fixed-facility incinerator processes and locations are highly controlled (Kastner and Phebus, 2004).

Under the CAA, EPA established emission standards for incinerators by placing limits on the amount of pollutants released into the environment. Many fixed-facility incinerators are equipped with flue gas-cleaning equipment that captures fly ash and air toxins from the incineration process (e.g., acid gases). The United Kingdom disposed of many infected animals during a BSE outbreak by using fixed-facility incinerators (Kastner and Phebus, 2004).

Figure 2–6. Fixed-facility incinerator. (Photo courtesy of FC Industries, Inc. Kansas City, MO)

2. Transportation

Carcasses need to be quickly identified, removed from the discovery sites (corrals, pens, ranches, etc.), and managed before decomposing to the point at which transportation is not feasible. In some cases, the mortality loss will be so high that carcasses may need to be removed from the discovery site and held in a temporary storage location prior to transportation to the management facility. Onsite disposal options (typically unlined burial, open-air burning, and composting) would require that some or all of the carcasses be transported within the premises. Offsite disposal options (i.e., mass burials, centralized composting, rendering, landfills compliant with RCRA, and fixed-facility incineration compliant with the CAA) would require transportation within the premises, as well as off of the premises.

3. Decontamination

After the removal of contaminated carcasses from mass animal health emergency sites, the decontamination of equipment, materials, and premises may be required to prevent or mitigate the spread of contaminants (APHIS, 2013a). EPA defines decontamination as the inactivation or reduction of contaminants by physical, chemical, or other methods to meet a cleanup goal (EPA, 2013a). Cleaning and disinfection is part of the decontamination process. EPA has the authority to regulate pesticides, specifically disinfectants. EPA defines disinfectants as pesticides that are used to kill or inactivate disease-producing micro-organisms on inanimate objects (EPA, 2014a). Because decontamination has the potential for human and environmental impacts, the issue will be addressed in this EIS.

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III. Affected Environment

This chapter broadly reviews the human environment in the major livestock-producing regions of the United States that may be impacted by a mass animal health emergency. CEQ defines the human environment as "the natural and physical environment and the relationship of people with that environment…When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment" (40 CFR part 1508.14). Therefore, this chapter will provide baseline descriptions of the relevant components of the human environment, which consists of livestock production and inventories, routine and non-routine livestock mortalities, carcass management, environmental resources (i.e., land cover and use; soil, air, and water quality; vegetation; and wildlife), human health, and climate change. Chapter 4 will discuss the potential impacts that the various carcass management alternatives have on the baseline conditions of the human environment outlined below.

A. U.S. Livestock Production and Inventories

This section's description of U.S. livestock production is limited to the commonly raised animals likely to experience significant impacts as a result of a disease outbreak. These animals include cattle and calves; sheep, lambs, goats, and other small ruminants (even-toed, hoofed mammals); swine (hogs and pigs); and poultry (meat-type chickens and turkeys). This EIS focuses on chicken produced for meat because of the relatively large size of this commercial industry within the poultry sector.

Agricultural production in the United States is dominated by specialized, highly productive, large-scale, and energy-intensive systems. In the last century, this specialization separated the production of crops and livestock to meet market demands, save costs by increasing the level of production, use advanced machinery, meet governmental incentives for export markets, and avoid risks associated with weather disasters, market, and societal pressures (Sanderson et al., 2013; Sulc and Franzluebbers, 2013).

Livestock inventories produced by the National Agricultural Statistics Service (NASS) provide estimates of the numbers of animals being raised in the United States at a given time (NASS, 2014). For the purpose of this EIS, these inventories can be used to identify areas where 50 tons or more of livestock carcasses may be generated at one time. The U.S. production of animals has gradually increased over time, despite yearly fluctuations which occur in response to market factors (figure 3–1). The major species raised as commodities are discussed individually in the subsequent sections.

Meat Animals: Production by Year, US

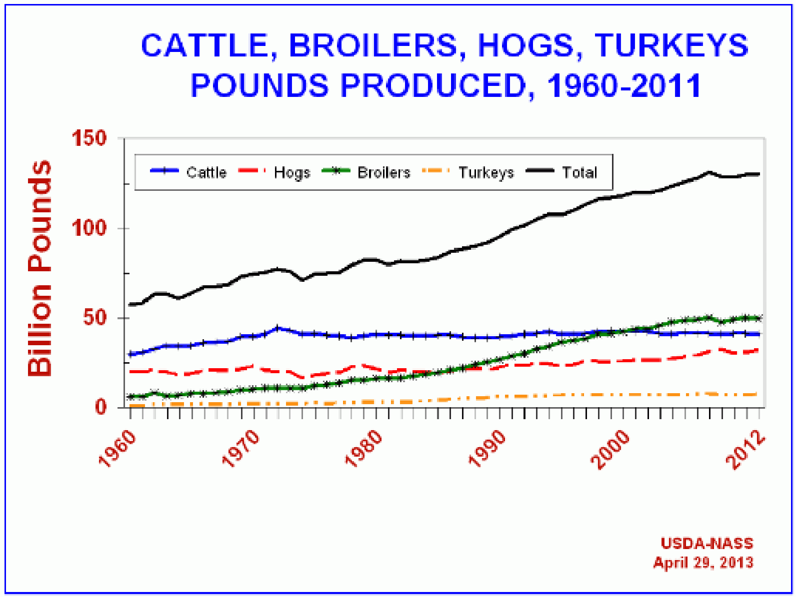

Figure 3–1. U.S. meat animals production by year. (Source: NASS, 2013.)

As of the 2012 Census of Agriculture, the total number of farms in the United States was 2,109,303 (NASS, 2014). The number of farms producing the various types of livestock, and the number of head for each type of livestock, is summarized in table 3–1.

Maps of U.S. livestock production data provided in this chapter are the latest available from NASS (NASS, 2014). Conducted only once every 5 years by NASS, the Census of Agriculture provides detailed data covering nearly every facet of U.S. agriculture at the national, State, and county levels. The data considers land use and ownership, production practices, expenditures, and other factors that affect the way farmers do business (NASS, 2013). The following sections provide available 2012 agricultural information, supplemented with 2007 data, along with current economic information and information from the Agricultural Outlook (Glauber, 2014)

1. Cattle

NASS recognizes three operation classes: cattle, beef cows, and milk cows. “The number of operations with cattle totaled 915,000 for 2012… Beef cow operations in 2012, at 729,000… The number of milk cow operations for 2012 totaled 58,000” (NASS, 2013). As of January 2014, all cattle and calves in the United States totaled 87.7 million head (Glauber, 2014). Cattle will be the focus of this section.

Cattle are raised throughout much of this country (figure 3–2); consequently, the potential for substantial cattle depopulation is possible in almost any geographic region of the United States. An animal health emergency involving 74 cattle at approximately 1,350 pounds would meet the threshold criteria of 50 tons (100,000 pounds) of carcass. Most of the large-scale cattle operations are in Western States (figure 3–2); the density of head in these areas is likely to create challenges at these locations in a mass animal health emergency.

Table 3–1. Livestock Inventory from the 2012 Census of Agriculture.*

Type of Livestock	Number of Farms	Number of Head
Cattle and calves (*Bos taurus* L., *B. indicus* L., and *B. primigenius* Bojanes Artiodactyla: Bovidae)	913,246	89,994,614
Milk cows (*B.* spp.)	64,098	9,252,272
Hogs and pigs (*Sus scrofa* L. Artiodactyla: Suidae)	63,246	66,026,785
Sheep and lambs (*Ovis aries* L. Artiodactyla: Bovidae)	88,338	5,364,844
Goats (*Capra hircus* L. Artiodactyla: Bovidae)	128,456	2,621,514
Equine (horses and ponies) (*Equus caballus* L. Perissodactyla: Equidae)	504,795	3,621,348
Broilers and meat-type chickens (*Gallus gallus domesticus* L. Galliformes: Phasianidae)	32,935	8,463,194,794
Chicken pullets for laying flock replacement (*G. gallus domesticus*)	26,749	110,297,133
Turkey (*Meleagris gallopavo* L. Galliformes: Phasianidae)	19,956	100,792,198

(Source: NASS, 2014, 2013; *Taxonomic information from AHPC, 2014.)

2. Sheep, Lambs, and Goats

As of January 2014, all sheep and lambs in the United States totaled 5.21 million head. Sheep include animals for breeding, ewes (female sheep) 1 year old and older, and market sheep and lambs. In the sheep population, 34 percent weighed more than 105 pounds (NASS, 2014). This type of distribution reflects animal age, as well as variation among varieties of sheep.

The 2014 goat inventory totaled 2.76 million head (NASS, 2014). Goat farming operations totaled 149,000 for 2012. Goat meat operations totaled 123,000, and milk goat operations total 30,500. There were 5,300 Angora goat operations. Places that own more than one type of goat are counted as only one operation in the total for the goat farming operations (NASS, 2013).

An animal health emergency involving 500 sheep at 200 pounds each would meet the threshold criteria of 50 tons (100,000 pounds) of carcass.

Sheep and goat populations are raised throughout the United States. (See figures 3–3 and 3–4 below.)

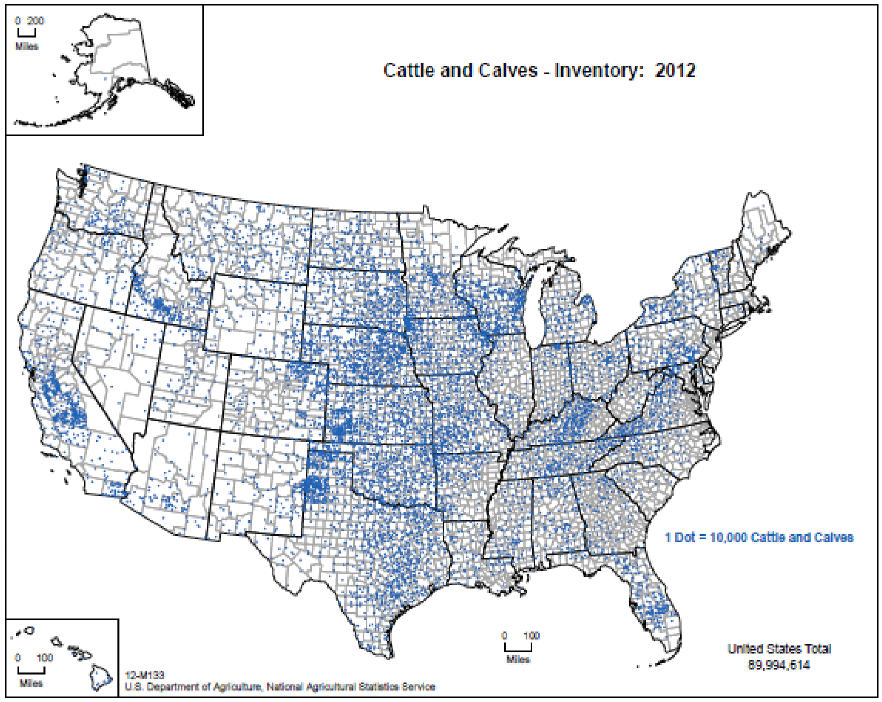

Figure 3–2. 2012 U.S. inventory of cattle and calves.
(Source: NASS, 2014.)

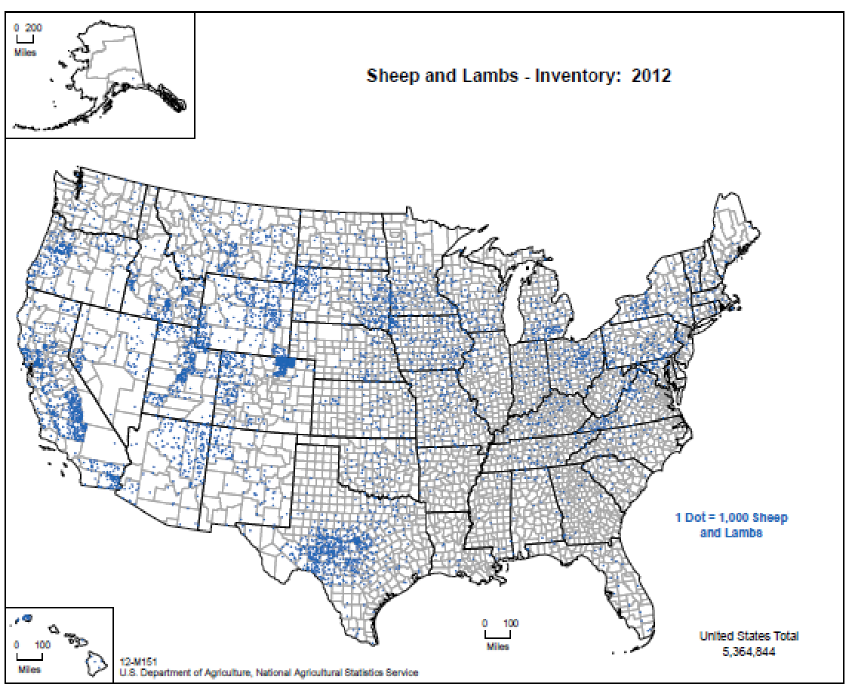

Figure 3–3. 2012 U.S. inventory of sheep and lambs.
(Source: NASS, 2014.)

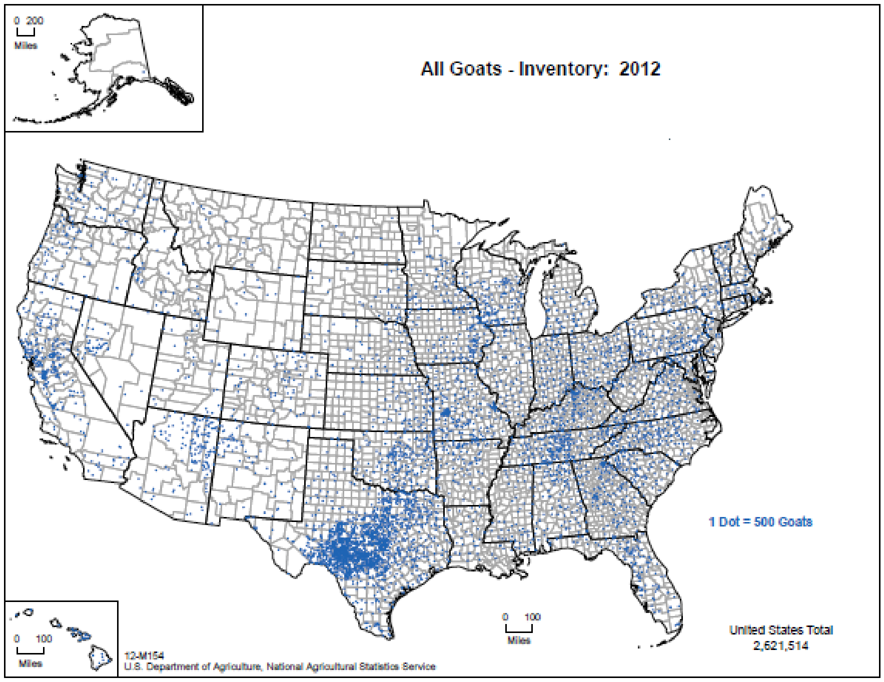

Figure 3–4. 2012 U.S. inventory of goats.
(Source: NASS, 2014.)

3. Swine

The term swine includes both hogs and pigs. In the United States, the inventory of all hogs as pigs, on March 1, 2014, was 62.9 million head (NASS, 2014). Fully grown (market) hogs average 240 to 270 pounds per animal (Pitcher and Springer, 1997). An animal health emergency involving 417 hogs at 240 pounds would meet the threshold criteria of 50 tons (100,000 pounds) of carcass. Conditions that favor swine production include non-stressful temperatures, proximity to grain, sparse human populations, an adequate water source, and nearby packing plants (Pitcher and Springer, 1997). Large swine operations located throughout the United States are shown below in figure 3–5.

4. Poultry

During the first quarter of 2014, chicken for meat (broiler) production was 9.28 billion pounds; during that same time interval, turkey production was 1.33 billion pounds (NASS, 2014). Stocking birds at high rates increases economic returns; however, this is coupled with higher mortality during production (AHPC, 2014). As indicated in figure 3–6, the top broiler-producing State was Georgia, followed by Arkansas, Alabama, Mississippi, and North Carolina (ERS, 2012).

The average weight of poultry is less than 10 pounds. Most chicken for meat is processed at 4.5 pounds live weight; however, this varies with the type of meat product that will be produced (Lessler and Ranells, 2007). An animal health emergency involving 22,222 broiler chickens at 4.5 pounds each would meet the threshold criteria of 50 tons (100,000 pounds) of carcass.

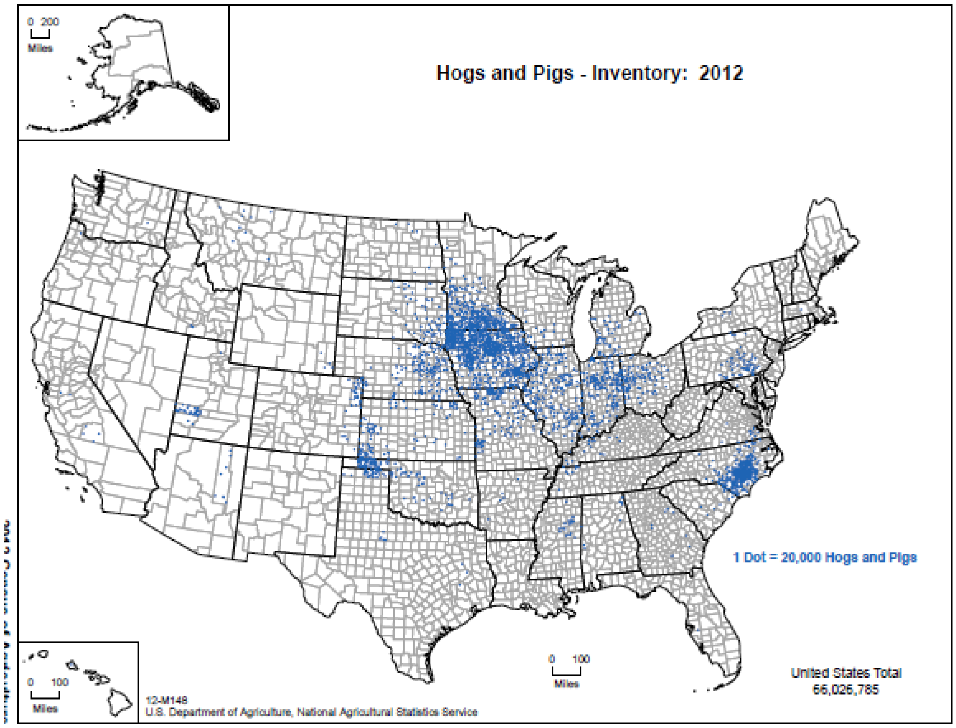

Figure 3–5. 2012 U.S. inventory of hogs and pigs.
(Source: NASS, 2014.)

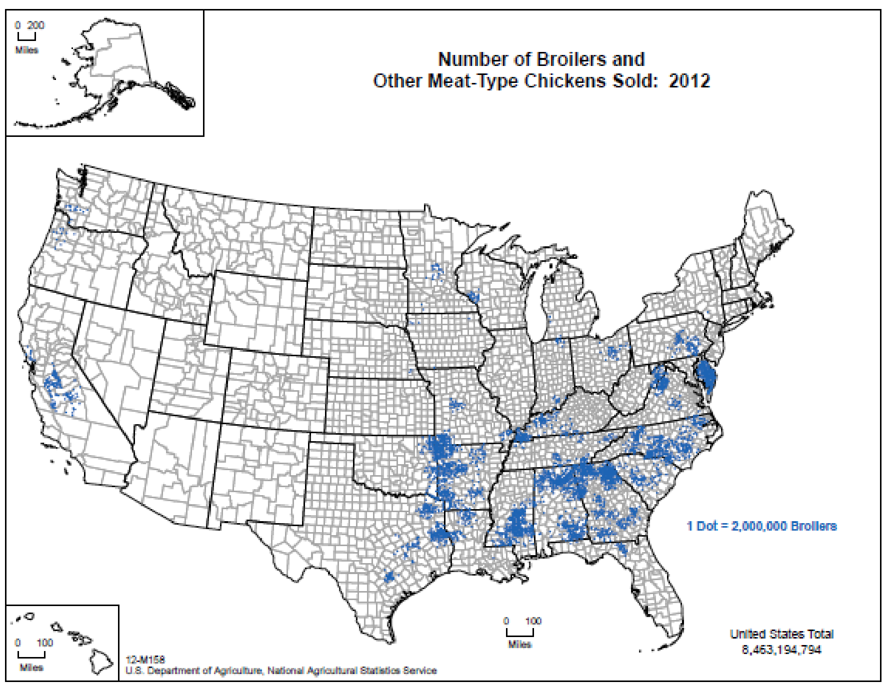

Figure 3–6. 2012 U.S. broilers and other meat-type chickens sold.
(Source: NASS, 2014.)

B. Livestock Mortality and Carcass Management

Livestock die from many causes, resulting in carcasses that must be properly managed to avoid spreading chemical, biological, and/or radiological contamination (depending on cause of death) and creating environmental impacts from the uncontrolled release of the decomposing byproducts. This section briefly identifies several causes of livestock deaths including natural disasters, and biological, chemical, radiological, and/or nuclear incidents. This section also includes resource requirements (inputs), byproducts (outputs), and environmental considerations of each of the management options. (For basic background information on the carcass management-options, please refer to Chapter 2—Alternatives).

Carcass composition plays a significant role in efficiently managing carcasses. Depending on the species, a fresh carcass typically contains 32- to 34-percent dry matter (dry matter is made up of protein, fat, and ash (Auvermann et al., 2004). The total fat content varies tremendously, with cattle and calves at about 10 to 12 percent fat, sheep around 22 percent, and hogs about 30 percent (Auvermann et al., 2004). Total carbon content is estimated to be 50 percent of carcass dry weight, and the nitrogen content is estimated to be one-third of the carbon fraction or 15 percent of dry weight (Kuhla et al., 2004).

Once an animal dies, leachate, biological and chemical~~s~~ agents, and gases are naturally released as the carcass degrades. Decomposition byproducts released into the environment can cause elevated levels of biochemical oxygen demand (the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material at a specific temperature and over a specific time period), ammonia-nitrogen, phosphorus, total dissolved solids (a measure of inorganic and organic substances suspended in a liquid; the measurement is used as an indicator of the presence of chemical contaminants), and chloride—particularly near burial sites. The relative concentrations of various pollutants vary over time because the chemicals released during degradation (both as gases and leachate) do not peak at the same time (Engel et al., 2004).

Environmental monitoring in water includes tests for chloride, ammonium, nitrate, nitrite, conductivity, total coliforms, and *Escherichia coli* (*E. coli*) because these are standard indicators for the presence of human pathogens and adverse environmental conditions. For example, an elevated concentration of nitrate in ground water is troublesome because nitrates in drinking water can be fatal to infants (Engel et al., 2004).

Carcasses may also release gases, such as methane, carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, hydrogen chloride, hydrogen fluoride, and polycyclic aromatic hydrocarbons. Carbon dioxide may also be released and is considered to be a greenhouse gas that could contribute to climate change effects.

Livestock production generates biomass. When animals die or are euthanized, the carcass biomass, associated manure, unconsumed feed, and bedding materials may need to be managed. If these materials are contaminated, proper management becomes a bigger issue. Sometimes the associated materials cannot be separated from the carcass. Therefore, the entire waste stream must be considered when choosing the disposal option.

1. Natural Disasters

Natural disasters including hurricanes, tornadoes, earthquakes, wildfires, drought, flooding, extreme heat, and unusual freezing events may generate a large number of livestock mortalities qualifying as a mass animal health emergency. Within this section, APHIS briefly considers where in the United States the events are likely to occur in order to establish the potential affected environment.

Natural disasters can be categorized as small-scale hazard events producing localized damages, and large-scale events that cause death, significant economic and social disruption (Middleton and Sternberg, 2013). They also can be recognized as either rapid-onset, intensive events of limited duration (acute hazards, e.g., earthquake, tornado) or slow-onset, pervasive events, often affecting larger areas over longer periods of time (chronic hazards, e.g., drought) (Middleton and Sternberg, 2013). Various strategies are used to combine types of hazards into categories for analytic purposes (table 3–2).

Table 3–2. Natural Disaster Hazard Categories and Examples.

Category	Examples
Severe Weather	Hail, tornadoes, lightning, severe thunderstorms, high wind, heavy rain
Flooding & Coastal Hazards	Storm surge, high surf, rip currents, flash floods, riverine flooding, urban flooding
Hurricanes	Tropical storms, typhoons
Geological Hazards	Earthquakes, tsunami, volcanic eruptions
Heat & Drought	High temperature, heat wave
Winter Weather	Ice storm, blizzard, heavy snowfall
Wildfire	Urban fires, brush fire
Landslides & Avalanches	Mud slides, debris flows

(Source: Gall et al., 2011)

Natural disasters in the United States, over the past 50 years, caused an estimated direct economic loss exceeding a half-trillion dollars, averaging almost $11.5 billion per year (figure 3–7; Gall et al., 2011). Losses due to natural disasters occur in different geographic and economic contexts and have varying degrees of devastating effects, creating different impacts at local and regional levels (figure 3–8; Ash et al., 2013).

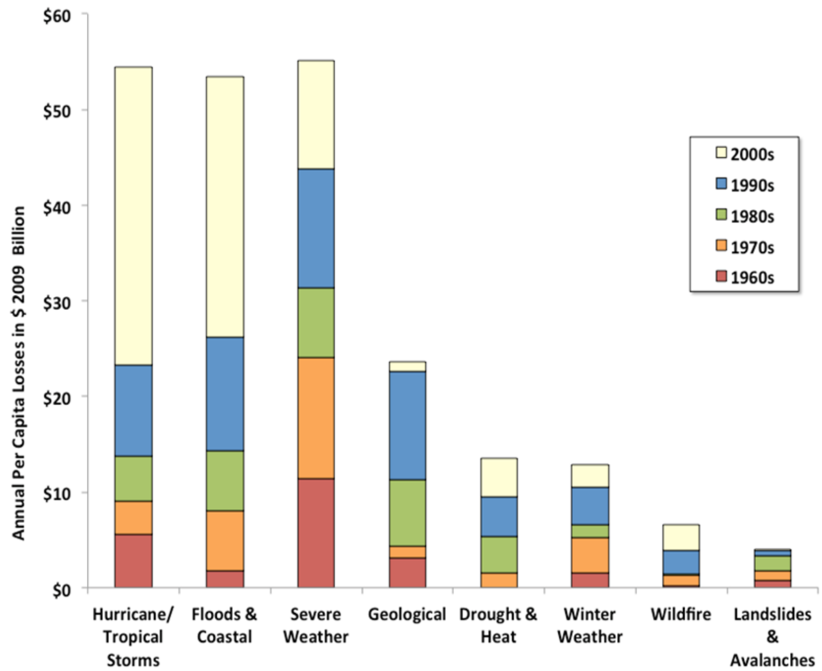

Figure 3–7. Temporal changes in annual losses by decade and hazard type. (Source: Gall et al., 2011)

Weather and climate disasters exceeded $1 billion in losses in 2011 from storms (e.g., tornadoes, hailstorms, and thunderstorms), storm-related excessive precipitation, severe snowstorms (blizzards and ice storms), and hurricanes (typhoon or tropical storms) (Kunkel et al., 2013). For example, in California, from 1993 to 2007, the most common causes of insurance indemnity and disaster payments were excess moisture, cold spells, and heat waves (Lobell et al., 2011).

Particularly for agriculture, property losses include both direct property damage and interruptions to the flow of production. Agricultural stock losses create a ripple effect as the loss flows through the economy (Ash et al., 2013). Consequently, disaster losses (in repair or replacement costs) divided by the gross domestic product (GDP) enable comparisons of impacts across disasters (figure 3–9; Ash et al., 2013).

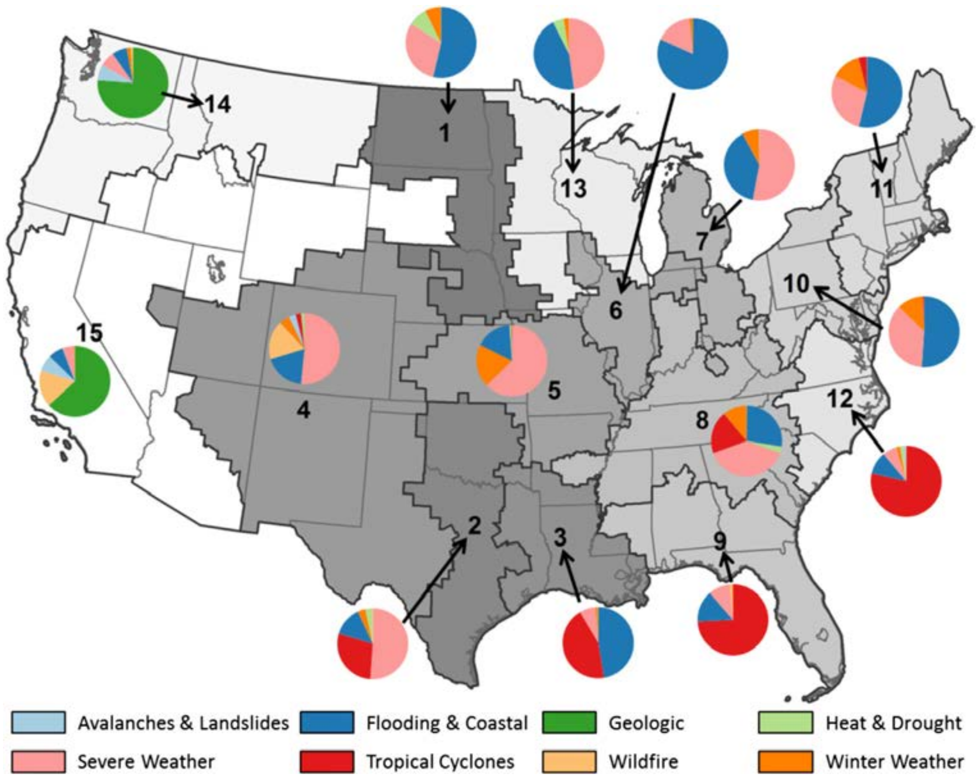

Figure 3–8. Distribution of losses by hazard types for U.S. regions using hazard data from 1980–2009. (Source: Ash et al., 2013.)

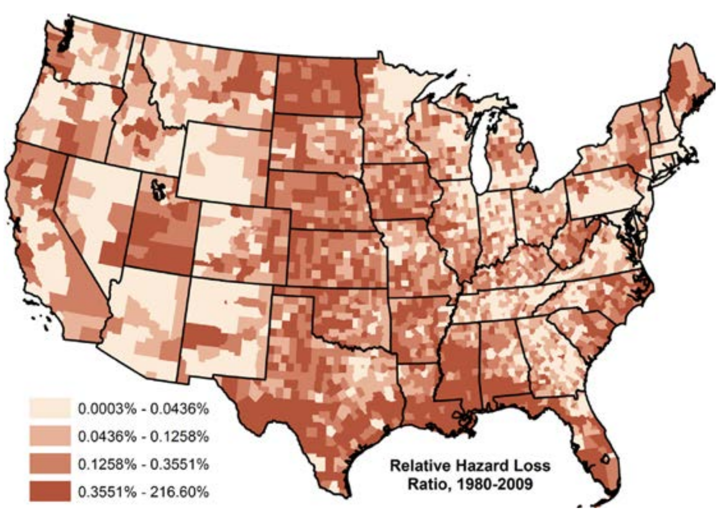

Figure 3–9. Relative hazard loss from 1980 to 2009. (Source: Ash et al., 2013.)

Extreme winter cold, snow, and ice can render forage inaccessible or unavailable, resulting in high livestock mortality. This may be exacerbated by drought in the previous summer when grazing livestock do not gain enough weight to survive the winter (Middleton and Sternberg, 2013). To the extent that overwintering livestock in the United States may be affected by the combination of extreme winter weather and lack of feed, this phenomenon periodically occurs in this country, for example, in North Dakota in 2013 (Waters, 2013). An analysis of U.S. weather data from 1961 to 2010 found more than twice the number of extreme regional snowstorms occurred as compared to the prior 60 years (Kunkel et al, 2013).

Since 1991, the entire country, other than the Western region, has experienced significantly greater numbers of extreme precipitation events (Kunkel et al, 2013). Floods are one of the leading causes of livestock death from natural disasters in the United States (figure 3–7). Floods can damage crops, kill or displace livestock, disrupt agricultural processing, and interrupt the flow of food and fiber to markets. For example, Hurricane Floyd (Sept. 15–16, 1999) killed approximately 3 million poultry, 800 cattle, and 30,000 hogs in North Carolina, while 50 animal operations with waste lagoons were flooded, releasing ammonia and other chemical forms of nitrogen into the environment (Aneja et al., 2001).

Further, the Texas Floods of 1998 left drowned animals along river bottoms for more than 100 miles of the Colorado, Guadalupe, and San Antonio Rivers, killing an estimated 23,200 cattle, 150 hogs, 10 horses, 100 sheep, and 150 poultry (Ellis, 2001). During Hurricane Katrina in August 2005, an estimated 10,000 cattle died or were displaced, over 6 million poultry were killed, and roughly 400 horses were evacuated (Clark, 2005). In contrast to floods, acute natural disasters (e.g., earthquakes and tornadoes) generally do not lead to mass animal health emergencies because their greatest magnitude of effects occurs to man-made structures. Similarly, actual livestock deaths due to wildfires devastate individual ranchers; however, overall the number of cattle fatalities is small compared to 30 million beef cattle nationwide (Brown and Barnard, 2012).

Many livestock farms are located in rural areas where major natural disasters leading to livestock mortality can occur (see figure 3–10). In most cases, disaster resources are limited in rural areas leading to slow response times.

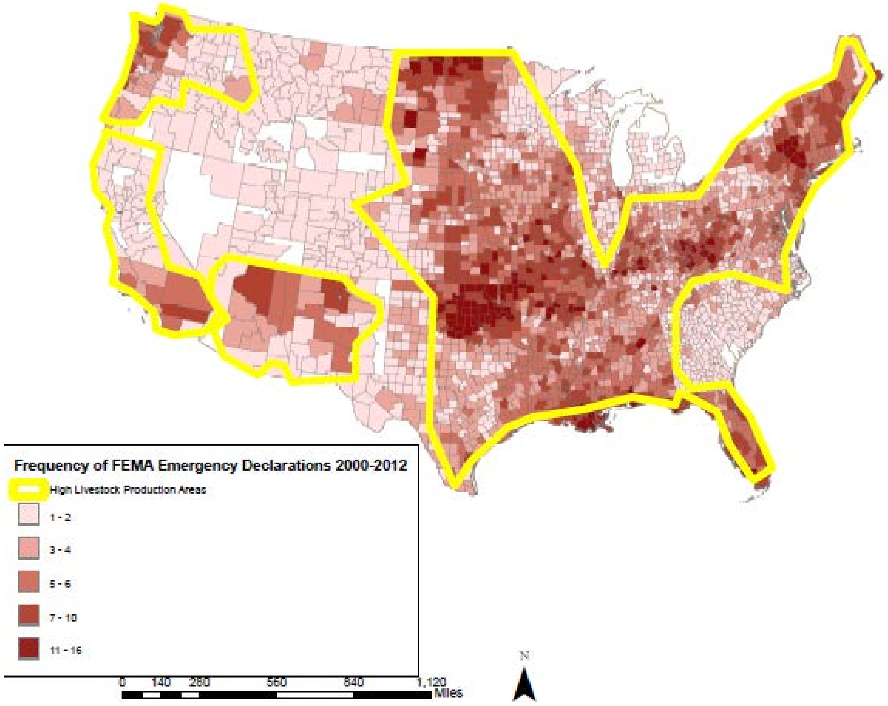

Figure 3–10. FEMA emergency declarations 2000–2012, and areas of high livestock production. (Sources: FEMA, 2013; NASS, 2014.)

2. Livestock Disease Issues

Disease outbreaks can originate from infectious animal diseases already endemic in this country, as well as FADs. The introduction of FADs could have severe consequences because U.S. herds lack natural immunity to these diseases (Brown and Torres, 2008; APHIS, 2013b). FAD outbreaks can generate a large number of carcasses. APHIS maintains lists of diseases of concern (see http://www.aphis.usda.gov/wps/portal/footer/topicsofinterest/applyingforpermit?1dmy&urile=wcm%3apath%3a%2FAPHIS_Content_Library%2FSA_Our_Focus%2FSA_Animal_Health%2FSA_Animal_Disease_Information), and pathogenic information is summarized in Brown and Torres, 2008.

APHIS classifies Tier 1 diseases of national concern as those posing the most significant threat to animal agriculture in the United States, including African swine fever (ASF), avian influenza (AI), classical swine fever (CSF), FMD, and virulent Newcastle disease. Tier 2 diseases are transmitted primarily by pests, and include heartwater, New World screwworm, Rift Valley fever, and Venezuelan equine encephalitis. Tier 3 diseases pose less risk and fewer consequences than those in Tiers 1 and 2. Tier 3 diseases include African horse sickness (AHS), contagious bovine pleuropneumonia, contagious caprine pleuropneumonia, glanders, melioidiosis, henipaviruses (Hendra and Nipah viruses), rinderpest, peste des petits ruminants, and tropical bont tick. APHIS excludes from its tiered lists endemic diseases already managed in this country (e.g., brucellosis, bovine tuberculosis, and hog cholera, hydatid cysts in liver, poultry with low pathogenic avian influenza (LPAI), scrapie, and trichinae).

OIE maintains a list of highly infectious diseases of concern (OIE, 2015b) (see http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2015/). FMD, peste des petits ruminants, lumpy skin disease, bluetongue, AHS, classical swine fever, Newcastle disease, swine vesicular disease, vesicular stomatitis, rinderpest, contagious bovine pleuropneumonia, Rift Valley fever, sheep pox and goat pox, ASF, and highly pathogenic avian influenza (HPAI) all appear on OIE's list. These diseases pose serious danger for animal health and welfare, an economic threat to animal livestock industries, and also a risk to human public health (zoonoses are infectious diseases that is transmissible from vertebrate animals to humans). The World Health Organization identified seven neglected endemic zoonoses (WHO, 2013) which include anthrax, bovine tuberculosis, and brucellosis.

Transmissible spongiform encephalopathy (TSE) diseases, thought to be caused by the presence of a misfolded protein (prion) in the animal's nervous tissue, cause slow degeneration of the nervous system, ultimately ending in death. TSE in sheep and goats is referred to as scrapie, mad cow disease or bovine spongiform encephalopathy (BSE) in cattle, chronic wasting disease (CWD) in deer and elk, and variant Creutzfeld-Jakob disease (vCJD) in humans. These diseases can lead to many animal deaths during an outbreak (Saunders et al., 2009a). For these TSE diseases, the safe management of the prions remains of particular concern because of their ability to remain infective in the soil and through the feed chain (Russo et al., 2009; Saunders et al., 2009b).

Prions will be used throughout this document as an example of a pathogen that is difficult to inactivate. Prions are highly resistant to inactivation processes that are normally effective against bacterial and viral disease agents, such as chemical and thermal means, and ionizing, ultraviolet, and microwave irradiation processes. Incineration, if done properly, is effective at deactivating prions. Although a slow process, prion adsorption onto soil particles is strongly irreversible, and the prions can remain infectious through oral consumption (Saunders et al., 2009a; Saunders et al., 2009b). Prions can survive conventional wastewater treatment systems (Hinckley et al., 2008). Consequently, carcasses infected with prions cannot be buried, rendered, or placed near healthy livestock or livestock feed or water supplies.

BSE became a public health issue when it was connected to vCJD in humans (APHIS, 2013c). In cattle, BSE is a fatal disease of the brain that causes a spongy degeneration in the brain and spinal cord. BSE has a long incubation period, from 2 to 8 years. Once an animal develops symptoms, the animal's condition deteriorates, and death usually occurs within the next 6 months.

FMDv will be used throughout this document as an example of a virus that, although easy to kill, is highly contagious. FMDv causes a highly contagious vesicular disease in ruminants. Direct contact of susceptible animals with contaminated fecal material, milk, saliva, and inanimate objects (e.g., wool) will transmit the virus (Brown and Torres, 2008; Kim and Kim, 2012). For a variety of reasons, vaccine use is limited. Most FMD infections in wildlife are due to transmission from livestock. Once FMD is eliminated from domestic animals, the disease disappears from wildlife (Brown and Torres, 2008). After an animal's death, FMDv is rapidly inactivated in skeletal and heart muscle tissue as a result of the acidic conditions that accompany rigor mortis (Kim and Kim, 2012). FMD survival during composting of swine (in a plastic-lined, passively aerated, insulated bin) did not exceed 21 days in one study (Guan et al., 2010). Management of FMD-infected carcasses must not provide a reservoir for the virus that can contaminate healthy livestock.

Natural methods of disease transmission are not the only way that pathogens can be spread. Agricultural bioterrorism is defined as the intentional targeting of a nation's livestock and crop resources (Noah et al., 2002) through the spread of biological agents to cause disease within the agriculture sector. Biological agents are bacteria, viruses, protozoa, parasites, or fungus that can be used as a weapon for bioterrorism. Biological agents considered to pose risk by terrorists are grouped into three categories; each category includes both human and animal pathogens.

- Category A (high-priority biologic agents) pose a risk to national security, and include variola major virus strains (smallpox), aerosolized *Bacillus anthracis* (anthrax) spores, *Yersinia pestis* (plague), *Clostridium botulinum* (botulism) toxin, *Francisella tularensis* (tularaemia), filoviruses (Ebola hemorrhagic fever, Marbug hemorrhagic fever), and arenaviruses (Lassa fever, and Junin (Argentine hemorrhagic fever)) (CDC, 2000).

- Category B biological agents exhibit reduced ease in dissemination and relatively lower morbidity and mortality. Category B agents include *Coxiella burnetti* (Q fever), *Brucella* species (brucellosis), *Burkholderia mallei* (glanders), alphaviruses (Venezuelan encephalomyelitis, eastern and western equine encephalomyelitis), ricin toxin from *Ricinus communis* (castor beans); epsilon toxin of *Clostridium perfringens*; and *Staphylococcus enterotoxin* B (CDC, 2000).

  A subset of Category B biological agents includes pathogens that are food- or waterborne, including but not limited to *Salmonella* species, *Shigella dysenteriae*, *E. coli* O157:H7, *Vibrio cholerae*, and *Cryptosporidium parvum* (CDC, 2000). The third highest priority biological agents could be engineered by mass dissemination and current emerging threats.

- Category C biological agents include Nipah virus, hantaviruses, tickborne hemorrhagic fever viruses, tickborne encephalitis viruses, yellow fever, and multidrug-resistant tuberculosis (CDC, 2000).

Veterinarian expertise, support, and response in animal health emergencies and agricultural bioterrorism attacks are essential given the potential zoonotic nature of many diseases. These diseases include anthrax, plague, tularemia, Ebola, Marburg, Lassa fever, Argentine hemorrhagic fever, Q fever, brucellosis, glanders, Venezuelan encephalitis, eastern and western equine encephalitis, salmonellosis, *E. coli* O157:H7, cryptosporidiosis, Nipah virus, hantaviruses, tickborne hemorrhagic fever viruses, tickborne encephalitis viruses, and yellow fever and are listed by the Centers for Disease Control and Prevention (CDC) as bioterrorism categories (Noah et al., 2002).

3. Chemical Issues

Livestock may be exposed to a chemical agent through various means, both intentionally and unintentionally. The chemical agent may cause the animal's death, or be present when the animal dies from other causes. Saegerman et al., 2006 classifies chemical contaminants in foods of animal origin into three categories including natural contaminants, such as mycotoxins (any toxic substance produced by a fungus), environmental contaminants linked to industrialization and/or urbanization (e.g., dioxins and dioxin-like compounds), and authorized chemicals (e.g., residues of veterinary medical products and pesticides). Saegerman et al. reports that chemical contaminants have seemed to decline during recent decades due to improvements in information and prevention. However, individual incidents causing mass animal health emergencies cannot be ruled out, and could have serious economic, health, or social repercussions; consequently, particular attention must be paid to chemical hazards in order to reduce risks to livestock and the consumer (Saegerman et al., 2006).

In general, chemical agents include:

- nerve agents, such as tabun (ethyl N,N-dimethylphosphoramidocyanidate), sarin (isopropyl methylphosphanofluoridate), soman (pinacolyl methyl phosphonofluoridate), GF (cyclohexylmethylphosphonofluoridate), and VX (o-ethyl-[S]-[2-diisopropylaminoethyl]-methylphosphonothiolate);

- blood agents, such as hydrogen cyanide and cyanogen chloride;

- blister agents, such as lewisite (an aliphatic arsenic compound, 2-chlorovinyldichloroarsine), nitrogen and sulfur mustards, and phosgene oxime;

- heavy metals, such as arsenic, lead, and mercury;

- volatile toxins, such as benzene, chloroform, and trihalomethanes;

- pulmonary agents, such as phosgene, chlorine, and vinyl chloride;

- incapacitating agents, such as BZ (3-quinuclidinyl benzilate);

- persistent and nonpersistent pesticides;

- dioxins, furans, and polychlorinated biphenyls (PCBs);

- explosive nitro compounds and oxidizers, such as ammonium nitrate combined with fuel oil;

- flammable industrial gases and liquids, such as gasoline and propane;

- poisonous industrial gases, liquids, and solids, such as cyanides and nitriles; and

- corrosive industrial acids and bases, such as nitric acid and sulfuric acid (CDC, 2000).

Chemical terrorism could affect commerce, human health, and animal health (CDC, 2000; Poschl and Nollet, 2007). Chemical agricultural bioterrorism can lead to inhalation or absorption of the chemicals causing immediate and obvious symptoms in livestock (CDC, 2000), and these chemicals may be found in livestock carcasses. Accidental introductions of chemical, such as through contaminated feed, can also contribute to mass livestock deaths. For chemical agents delivered through contaminated food or water, contamination of the food supply could continue undetected for extended periods (CDC, 2000).

In 1999, in Belgium, a tank of recycled fats that used to produce animal feed was accidentally contaminated by PCB oil and dioxins (mainly furans). Poultry and pigs were fed the contaminated feed (Covaci et al., 2002). In 2007, in the United States, swine were accidentally contaminated with melamine. While swine were eventually cleared for consumption (FDA, 2007), that may not always be the case. While contaminates may not always kill the livestock, if the animals cannot be consumed (either due to legitimate human health concerns or the public perceptions of health issues), euthanizing the livestock may be the only option. The result may be a carcass contaminated by the chemical agent, as well as by toxins used during euthanasia.

4. Radiological Issues

Radiation is energy that travels in the form of waves or high speed particles (EPA, 2013b), and includes sources such as microwaves, electrical power lines, and sunshine. Radiation is used in nuclear power and nuclear weapons. The type of radiation produced by a nuclear power plant release and detonation of a nuclear weapon is called ionizing radiation. Ionizing radiation includes alpha and beta particles, X-rays, and gamma rays (Bushberg et al., 2007; Karam, 2005; Poschl and Nollet, 2007). Ionizing radiation has enough energy to break chemical bonds in molecules (such as DNA) or remove tightly bound electrons from atoms (EPA, 2013b). Radioactivity is the property of some atoms which causes them to spontaneously give off energy as particles or rays (EPA, 2013b). Radioactive atoms emit ionizing radiation when they decay. When humans or other animals are exposed to radiation, they have been irradiated. If radionuclides come in contact with skin or clothing, the items are considered externally contaminated. If radionuclides are ingested, either by inhalation, consumption, or introduction through wounds, these are internally contaminated.

Livestock may be exposed to radiological agents either accidentally or intentionally. The source may be either naturally occurring radioactivity, also known as "natural background radiation," or anthropogenic (sources originating in human activity). Natural background radiation has been present since the earth was formed, and every animal receives small doses of radiation at all times (Berger, et al., 1987). Animal cells have evolved to be able to repair any damage done by background irradiation. Carcasses that are only at background level would not be considered contaminated.

Anthropogenic radioactive materials may be released via an improvised nuclear device (also known as an IND, nuclear weapons bought or stolen from a nuclear state or created illegally), a nuclear power plant accident, a dirty bomb, or through radioactive powders or liquids with high dispersive capabilities.

Exposure to anthropogenic sources of radiation could occur through exposure to soil or contaminated air, water consumption, or the consumption of bioaccumulated levels in milk, meat (Poschl and Nollet, 2007), and/or vegetation. Radiation-releasing incidents causing widespread contamination of animals could disrupt the food supply until the area is decontaminated, or weathering degrades the contamination (Poschl and Nollet, 2007). Note that dispersion of radionuclides due to wind and rainfall may result in the contamination spreading to other geographic areas, potentially contaminating more animals, and potentially generating more carcasses should those animals have to be disposed. Also note that the perception of the consuming public will likely supersede the scientific validation that radioactivity is no longer an issue with livestock in a previously contaminated locality. Most State departments of agriculture will condemn those animals in order to preserve the integrity of their livestock industry.

Airborne radioactive particles may be inhaled by animals, and radioactive particles may settle on pastures, and then be consumed by the animals (Karam, 2005; Poschl and Nollet, 2007). If livestock consume radioactive particles, radiation will be present in their carcasses.

An example of a recent radioactive release disaster occurred at the Fukushima Daiichi Nuclear Power Plant in Japan in 2011. A large amount of radioactive substances were released into the environment. Radionuclides attributed to the nuclear fallout (cesium-134 and cesium-137) were detected in all cattle that were tested (Fukuda, et al., 2013). Only cesium-133 is stable. Cesium-137 has a half-life of 30 years; cesium-134 has a half-life of 2 years.

During a radiological incident event, APHIS would work cooperatively with the Department of Health and Human Services (HHS) and the EPA to manage carcasses (FEMA, 2008). Released radioactive materials that have influence on carcass management are within the scope of this EIS. However, because the likelihood of a radiological event is thought to be lower than a biological or chemical event due to the lack of availability of radioactive materials, and the lack of knowledge and skills necessary to create and deploy this type of weaponry, the impacts discussed within this document will be primarily focused on biological and/or chemical contaminants.

5. Euthanasia

Euthanasia is not a carcass management option; however, the practice will be discussed within this document as it relates to the presence of toxic chemicals within carcasses. Livestock may be euthanized in order to humanely allow the animal to die because it is injured, sick, may be a detriment to other animals or humans in the area, or there is a lack of resources to support the animal. Euthanasia methods are designed to cause as little pain or stress as possible to the animal. Methods may include intravenous injections of barbiturates, such as sodium pentobarbital, or shooting with a bullet (which may contain lead) or captive bolt. Injectable drugs work to suppress the central nervous system. A captive bolt is a gun that uses gunpowder or compressed air to propel a bolt into the brain of the animal, causing rapid unconsciousness and death. A bullet or captive bolt methods destroy or make the brain nonfunctioning, instantly producing unconsciousness, and are considered humane ways to destroy animals when properly done. Captive bolts do not contaminate tissues with chemicals; barbiturates and lead can persist in carcass tissues.

6. Management Options

This section summarizes information on the various carcass management options, including the inputs and outputs associated with each option, their costs, and locations. Management options vary in accessibility, size, processing speed, and capacity. These varying traits become part of the considerations for management options.

The choice of which management option to use is influenced by many factors. As presented in Chapter 2—Alternatives, carcass disposal methods include unlined burial, open-air burning, composting, rendering, landfills compliant with RCRA, and fixed-facility incineration compliant with the CCA. All of these methods have the potential to impact the environment to some extent.

During any mass animal health emergency, the available carcass management options need to be considered as part of a logical framework. Figure 3–11 presents a schematic developed by APHIS to guide individuals using checklists that determine if a management option is a viable alternative.

a. Unlined Burial

The primary resources required for unlined burial include the appropriate area to temporarily store accumulated carcasses awaiting burial, the appropriate area to bury carcasses, moving and excavation equipment, and equipment fuel. Uncontrolled gases and leachate from carcasses, as well as exhaust from excavation equipment, are byproducts of unlined burial. There is also a loss of the use of the land. (See figure 3–12 for a flow chart of the inputs and outputs associated with the unlined burial of carcasses.) The environmental impacts of these outputs will be discussed in chapter 4.

Carcass Management Decision Cycle

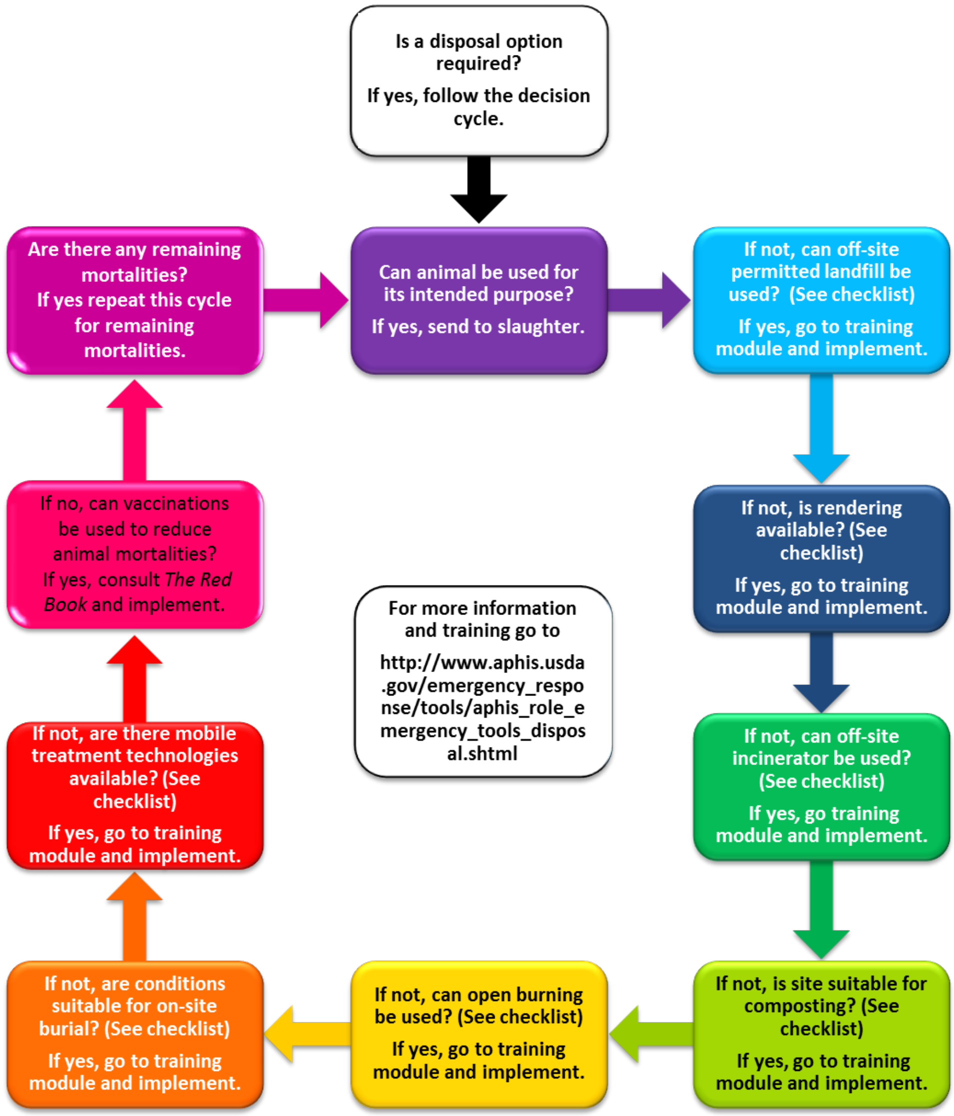

Figure 3–11. How to select among current carcass management options. (Source: APHIS, n.d.–3)

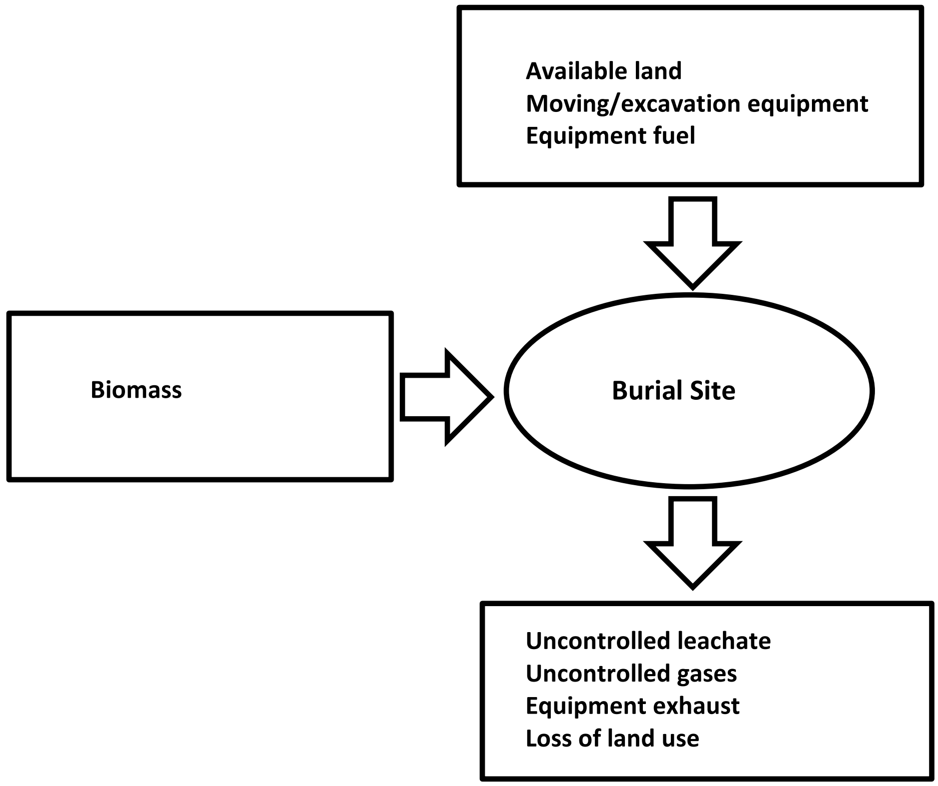

Figure 3–12. Flow chart of the inputs and outputs associated with the unlined burial of carcasses. (Credit: USDA–APHIS–VS)

b. Open-Air Burning

Resources required for open-air burning includes the appropriate area to temporarily store accumulated carcasses waiting burning, the appropriate area to burn the carcasses, the necessary equipment and equipment fuel, and fuel and combustibles for the pyre. Machinery is necessary to dig a shallow trench on which to build the pyre, and to move the carcasses onto the pyre. A mixture of fuels, such as straw or hay, untreated timbers, kindling wood, and coal, or diesel fuel are required to ignite the pyres (a pile of combustible material) and raise the temperatures to the degree necessary for carcass incineration.

Fully burned carcasses produce a solid waste byproduct (bone and ash) which is free of most pathogens (one potential exception being prions) (Ellis, 2001), and free of decaying material that would otherwise attract pests (APHIS, 2004). However, other outputs include potentially high levels of air pollution, large amounts of potentially contaminated ash (dioxins, heavy metals), leachate, and unwanted heat. In addition, there is a temporary loss of use of the land. (See figure 3–13 for a flow chart of the inputs and outputs associated with open-air burning of carcasses.)

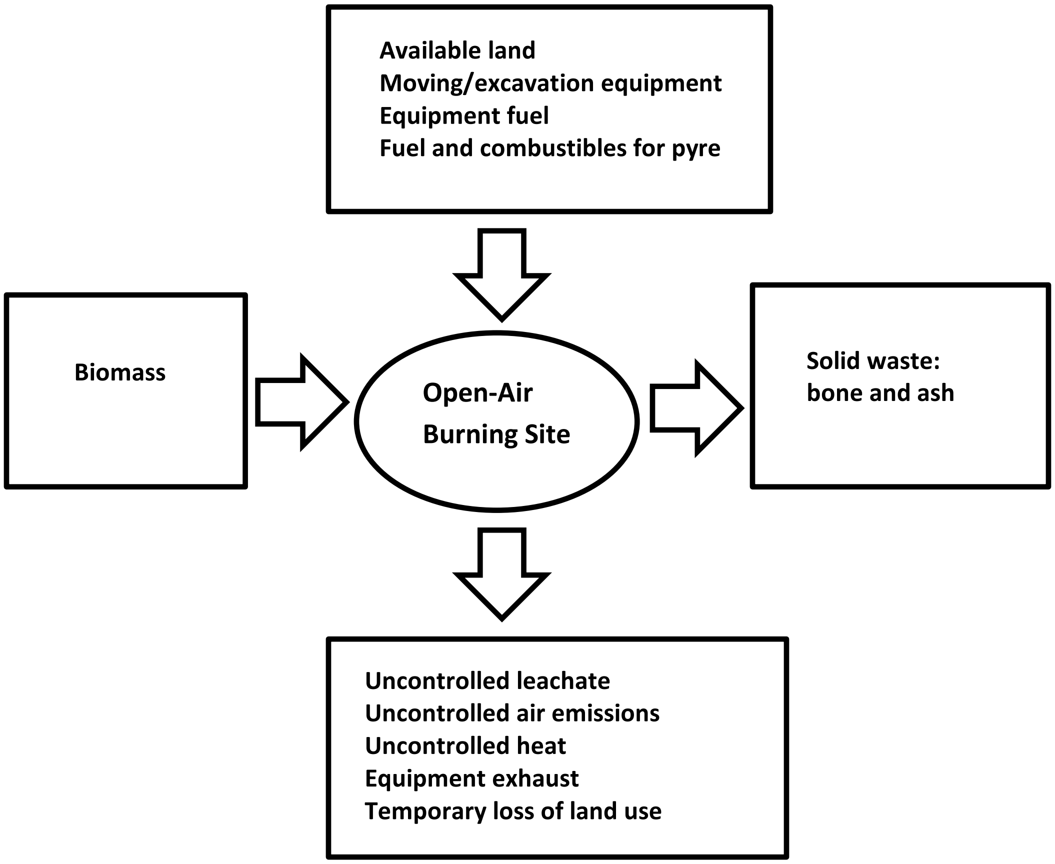

Figure 3–13. Flow chart of inputs and outputs associated with the open-air burning of carcasses. (Credit: USDA–APHIS–VS)

c. Composting

Resources required for composting include the appropriate area to temporarily store accumulated carcasses waiting to be composted, the proper area to compost, composting equipment, and the necessary nutrients and water. Composting equipment includes machinery to lift, mix, move, and/or grind composting piles, and instruments for monitoring the physical and chemical properties of the composting piles (pH, temperature, etc.). A front-end loader can be used to move the carcasses, and turn the pile every 3 to 6 months (Auvermann et al., 2004), as well as load the final compost into a spreader truck. Effective carcass composting requires layers of carbon sources and bulking agents, adequate aeration, and water (Dougherty, 1999). Carbon source bulking agents, also referred to as amendments, provide the necessary nutrients for decay. These include spent horse bedding (a mixture of horse manure and pinewood shavings), wood chips, refused pellets, rotting hay bales, peanut shells, and/or tree trimmings.

Compost piles are sometimes placed directly on the bare ground; however, a barrier may also be placed between the ground and the piles to help contain leachate. Impermeable barriers can be made of polyvinyl chloride (PVC), plastic, concrete, or asphalt. A layer of biodegradable carbon sources (e.g., straw, sawdust, corn stalks, and yard waste) may also be placed beneath carcasses to act as a sorbent and biofilter layer used to capture and assist in degrading pollutants).

Composting has the potential to produce a valuable stabilized organic residue that is a dark brown to black soil called humus. Containing primarily nonpathogenic bacteria and plant nutrients, humus may be spread over the land as a soil additive (Mukhtar et al., 2004), as long as harmful pathogens are not present. Incompletely degraded humus (humus that still contains pathogens) or compost made from contaminated animals should not be sold as a commodity and needs to be disposed of as a solid waste. In addition to humus, composting produces water vapor, carbon dioxide, heat, and leachate. There is also a temporary loss of the use of land. (See figure 3–14 for a flow chart of the inputs and outputs associated with composting carcasses.)

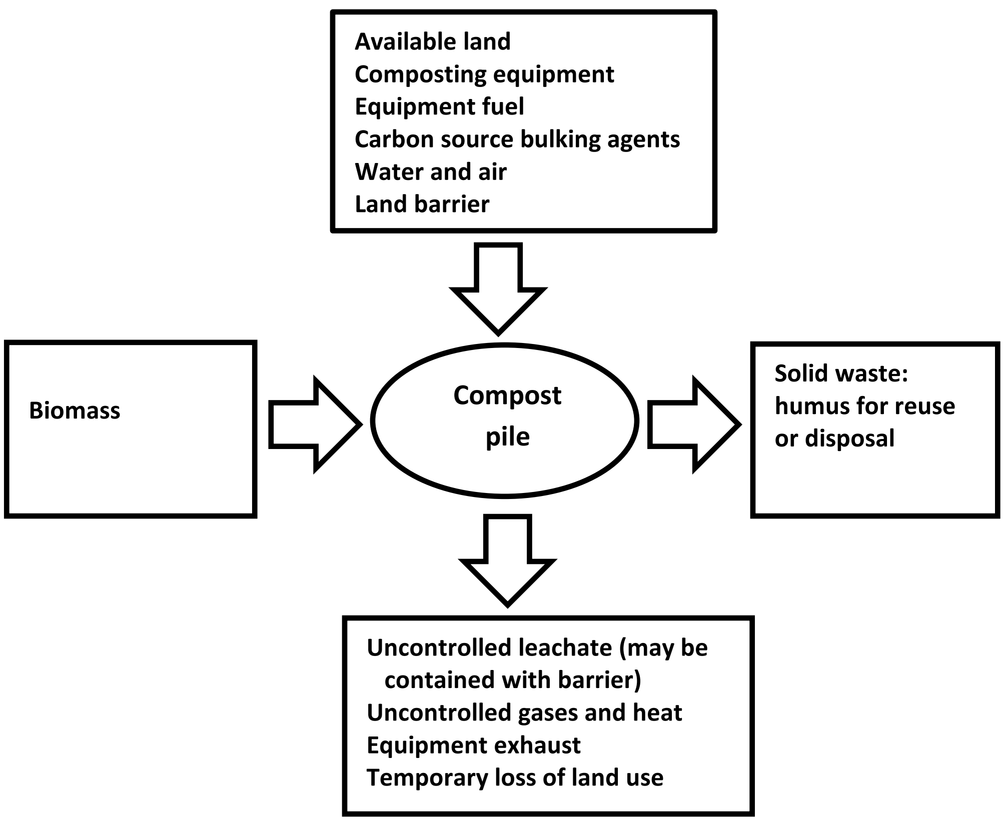

Figure 3–14. Flow chart of inputs and outputs when composting carcasses. (Credit: USDA–APHIS–VS.)

Proper layering of the carbon sources and bulking agent material, with adequate aeration, will ensure there is uniform temperature and moisture content throughout the compost pile (Dougherty, 1999). Proper layering will also enhance microbial activity, deodorize released gases, and prevent access to carcasses by insects and scavengers that could disperse disease agents from the carcasses (Mukhtar et al., 2004).

d. Rendering

Resources required for rendering include transportation equipment and fuel to move the carcasses offsite and a rendering facility that will accept the carcasses. The appropriate area to temporarily store accumulated carcasses may also be necessary. Rendering byproducts from processing carcasses generated by animal health emergencies will not likely be sold for human or animal use. The necessary machinery and equipment includes crushers, mixers, mills, screeners, centrifuges, cookers, presses, and evaporators. Equipment can be designed for continuous processing of carcasses or to operate under a batch system.

There are three major end products from the rendering of carcasses: carcass meal (solid proteins), melted fat or tallow, and water (Auvermann, 2004; Meeker, 2006). Wastewater that is created during the process must be disposed of properly, typically under a wastewater discharge permit (EPA, 2014b; see the following EPA Web site for information on these permits: http://water.epa.gov/polwaste/npdes/). There will also be controlled emissions from rendering machinery and transportation equipment exhaust. (See figure 3–15 for a flow chart of the inputs and outputs associated with rendering carcasses.)

Usually carcass rendering processes include crushing the raw materials, directly or indirectly heating the carcasses, evaporating moisture, separating fat from the high-protein solids, pressing any unmelted residue to remove additional water, centrifugation (spinning material around a central axis to separate out contained materials) of aqueous solutions, sometimes solvent extraction of protein parts to remove more tallow, and drying and grinding the protein materials (Meeker, 2006). The final end product of carcass rendering is free of many pathogens (Meeker, 2006) and unpleasant odors, provided that the proper processing conditions are used.

The capacity of each rendering plant varies (Auvermann, 2004); however, the industry reports typical rendering operations can process 1 million pounds of raw materials in a 24-hour period (Sindt, 2006). Hide removal and carcass cleaning become more difficult when a carcass is in advanced stages of decomposition; therefore, it is preferred that only carcasses in the early stages of decomposition are sent to a rendering plant.

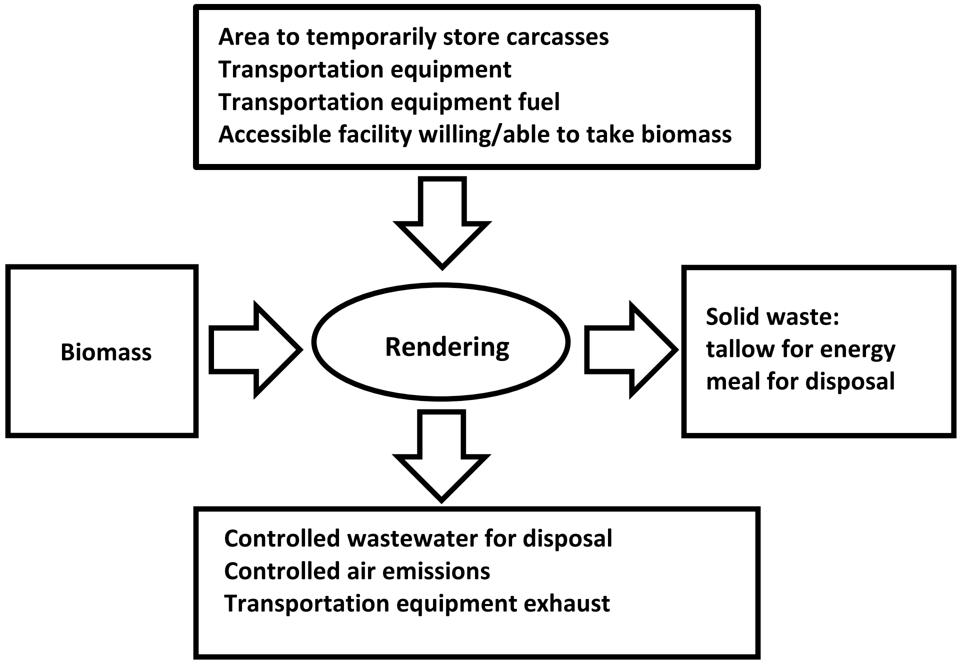

Figure 3–15. Flow chart of the inputs and outputs when rendering carcasses. (Credit: USDA–APHIS–VS)

Carcass meal may be disposed of as a solid waste or used as biofuel if it cannot be added to fertilizer or animal feed. Since 2001, the U.S. Food and Drug Administration (FDA) prohibited use of most mammalian protein in feeds for ruminant animals due to concerns regarding the presence of infective prions (21 CFR part 589). Tallow may be used in livestock feed, for production of fatty acids, or it can be used for making soap. When fats produced by rendering processes are burned, they can be used as biofuels. Of the approximately 11 billion pounds of annual production of rendered fats, anywhere from 43 to 116 million gallons of biodiesel are produced (3 to 8 percent). This low percentage is expected to increase over time (Sindt, 2006). Wastewater is either released as steam during the rendering process, or it must be disposed of properly. Proper disposal of wastewater may include flow into a public water treatment facility, under a permit from the National Pollution Discharge Elimination Permit System (NPDES).

e. Landfill

The primary resources required for landfill include the appropriate area to temporarily store accumulated carcasses awaiting burial, a landfill that will accept the carcasses, and transportation equipment and fuel. While leachate and gases are produced in landfills, they must be collected and contained, in accordance with regulatory requirements, to protect the surrounding environment. There will also be exhaust from transportation equipment. (See figure 3–16 for a flow chart of the inputs and outputs associated with placing carcasses in landfills.)

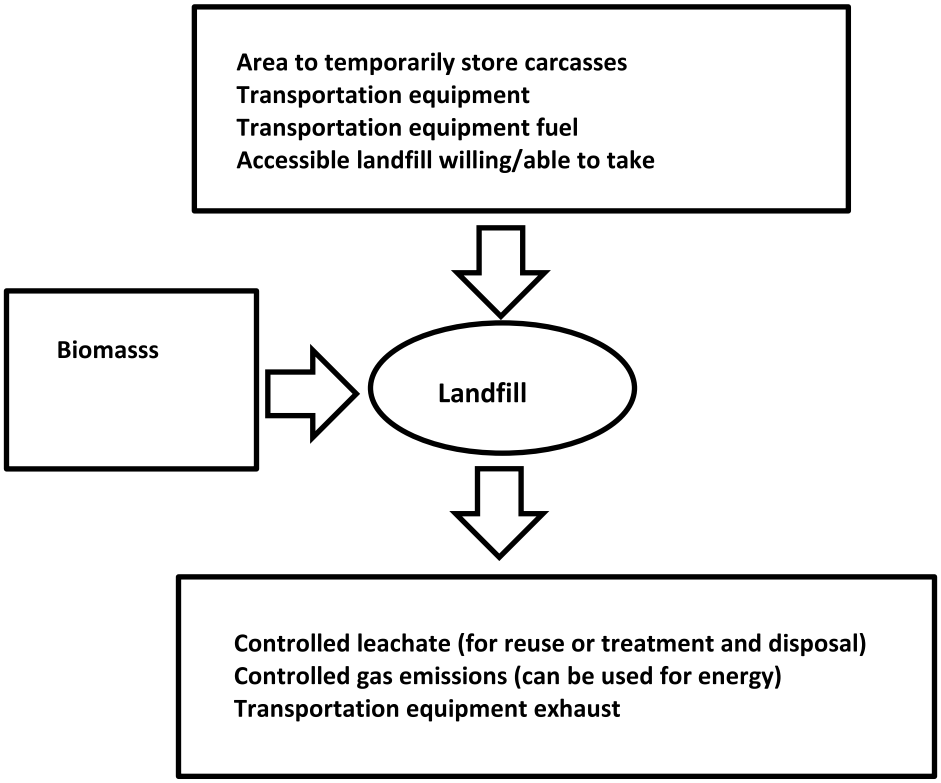

Figure 3–16. Flow chart of inputs and outputs when using RCRA-compliant landfills for disposal of carcasses. (Credit: USDA–APHIS–VS)

Landfills are permitted to receive different kinds of waste based on the characteristics of the facility. EPA recognizes RCRA Subtitle C landfills (hazardous waste landfills, discussed in greater detail below), RCRA Subtitle D landfills (municipal solid waste landfills, discussed in greater detail below), industrial waste landfills, construction and demolition debris landfills (EPA, 2014c). EPA requires facilities to follow design and operating standards, ground water monitoring programs, and corrective action measures. The primary features are composite liners, leachate containment systems, and gas collection systems; there are liner requirements and location restrictions. The requirement for at least daily cover with earthen materials (or an approved alternative) is specifically designed to control disease vectors, odors, blowing litter, and scavenging (40 CFR § 258.21(a) and (b)). In addition to EPA's Federal policies, landfill operators must meet State and local landfill regulations.

Potential risks to the public health from decomposing animal carcasses in landfills can influence an operator's decision regarding whether to accept carcass material, even if the landfill is permitted to receive carcasses.

Some landfill owners refused to accept carcasses for burial during the 2001 FMD outbreak in the United Kingdom (Nutsch and Spire, 2004), and in Wisconsin for the disposal of deer and elk carcasses stemming from an outbreak of CWD.

Landfills treat byproducts of decomposition, such as leachate, prior to release into the environment. Landfills may recover byproducts of decomposition, such as methane and carbon dioxide (biogas) for use as an energy source (EPA, 2014c), or release gases into the environment in a controlled manner. Federal and/or State regulations require most large landfills to capture landfill gas and combust it by flaring or treating the gas so it can be used in a landfill gas energy system (EPA, 2011a). Flaring will just burn the gas with no energy recovered, while harnessing the power of landfill gas will reduce greenhouse gas emissions, offset the use of non-renewable energy resources, improve local air quality, and provide revenue for landfills (EPA, 2011a). Recovered methane can be sold directly to an end user for use as natural gas fuel (DOE, 2007).

During an emergency, time constraints affect every decision. The availability of preexisting landfills can become an advantage when other options fail, particularly if the landfill can receive a relatively large quantity of carcasses. Previously approved Subtitle D landfill sites could allow a rapid response to an emergency if the site(s) already have the needed environmental protection features.

Animal carcasses would typically be categorized as nonhazardous waste. RCRA Subtitle D regulates the management of nonhazardous solid wastes. Under Subtitle D, permitting and monitoring of municipal and non-hazardous waste landfills are the responsibility of the State. State and local governments are the primary planning, permitting, regulating, implementing, and enforcement authorities for disposal of nonhazardous solid wastes (EPA, 2014c). EPA also issues regulations under the CAA that apply to emissions from large landfills; regulations issued under the Clean Water Act (CWA) also may apply (EPA, 2014c).

However, if livestock carcasses contain levels of contaminants that are considered a hazard to humans and/or the environment, the carcasses may be considered hazardous waste. Subtitle C of RCRA establishes a Federal program that manages hazardous wastes. Under RCRA Subtitle C, EPA has the primary responsibility for the permitting of hazardous waste treatment, storage, and disposal facilities (EPA, 2014c). EPA sets minimum standards that include minimal requirements for the location, operation, design (e.g., liner, leachate collection, run-off controls), ground water monitoring, corrective action, closure and post-closure care, and financial assurance responsibility (40 CFR parts 257 and 258) for landfills. However, States primarily implement RCRA hazardous waste regulations;

additional State requirements can be more stringent than Federal regulations.

Carcass disposal at landfills would occur in Type 1 facilities. Type 1 facilities are required to meet RCRA Subtitle D requirements, as well as other applicable Federal and State regulations. These types of facilities can accept most types of carcasses and are designed to manage leachate and gases that are a result of degradation of organic, such as those associated with carcass disposal. It must be noted than many landfills have contractual obligations to accept waste from other sources, and these landfills may not have available additional capacity to accept large quantities of animal carcasses.

Table 3–3 lists the 10 largest landfills in the United States to show their dispersion throughout the country and estimates of capacity. Carcass management in this EIS is not contemplating use of only these landfills.

Table 3–3. The 10 Largest Landfills in the United States.

Name of Facility	State Located	Capacity (Tons/day)
Roosevelt Regional Landfill	WA	8300
Denver Arapahoe Disposal Site	CO	6000–8000
Columbia Ridge Landfill	OR	6000–8000
Pine Tree Acres	MI	6000–8000
Atlantic Waste Disposal	VA	6000–8000
El Sobrante Landfill and Recycling Center	CA	6000–8000
McCarty Road Landfill	TX	7200
Sunshine Canyon Landfill	CA	8400
Newton County Landfill	IN	9100
Apex Regional Waste Management Center	NV	9200

(Source: CNBC News, 2014)

f. Fixed-Facility Incineration

Resources required for incineration include the appropriate area to temporarily store accumulated carcasses awaiting incineration, an incinerator that can accept the carcasses, and transportation equipment and fuel. Typically diesel, natural gas, or propane fuel is needed to ignite the high water content carcasses.

Incineration produces ash, air emissions, and heat. Burning waste materials to ash requires sustained high temperatures, generally over 1562.0 ºF (850 ºC). (See figure 3–17 for a flow chart of the inputs and outputs associated with the fixed incineration of carcasses.)

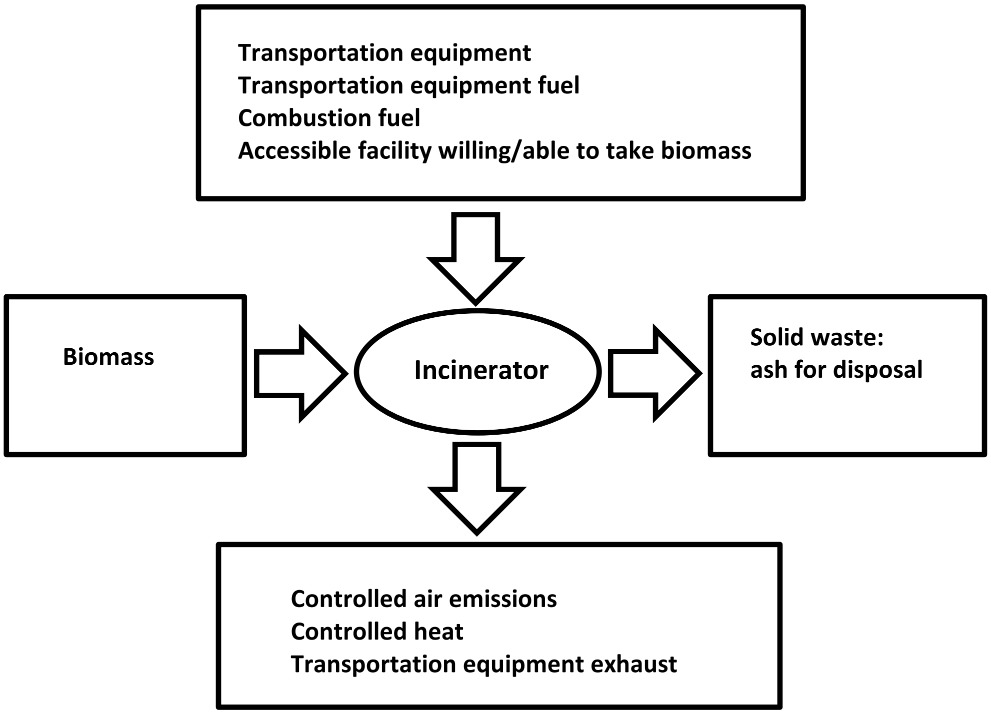

Figure 3–17. Flow chart of the inputs and outputs when using CAA-compliant incinerators for disposal of carcasses. (Credit: USDA–APHIS–VS.)

It is not easy to determine exactly how many fixed-facility incineration facilities are in the United States, and there is no current representation of all of these on a national map. Facilities accepting solid wastes do not necessarily mean they accept animal carcasses, and may instead be referring to all organic wastes which include animal waste (EPA, 2011b). The capacity or productivity of incineration plants (volume of incinerated wastes produced per time unit) varies with the available type, size, and number of equipment and other resource factors. Some plants can treat more than 100,000 tons of waste per year.[1] Information on commercial and industrial solid waste incinerators is available through the EPA Web site at http://www.epa.gov/oaqps001/combustion/incinmap.html (EPA, 2011b).

g. Other Available Management Options

Under the adaptive management alternative, other available nonstandard disposal options may be considered. Examples of nonstandard options include, but are not limited to, air-curtain incineration, alkaline hydrolysis, anaerobic digestion, microwave sterilization, and gasification. These

[1] It must be noted that many fixed-facility incinerators are contractually obligated to process waste from other sources, and may not have sufficient additional capacity to process large quantities of animal carcasses.

example unit options are mobile and can be deployed directly to an affected premise.

Air-curtain incineration typically forces a curtain of air over the burn chamber of a firebox (a walled unit where the fire is enclosed) (Harper, et al., 2008). Alkaline hydrolysis uses a base (typically sodium hydroxide or potassium hydroxide) to break chemical bonds within animal tissues by inserting water molecules. The process is further accelerated by applying heat and pressure. Anaerobic digestion uses a series of chemical processes to preserve carcasses under acidic conditions, and then anaerobically (without oxygen) decompose the carcass while producing biogas.

Microwave sterilization uses the direct application of multiple, high-energy microwave generators to treat waste. With water, high temperatures and pressure, the waste is sterilized. Lastly, gasification is a process in which solid and liquid materials are converted to a combustible gas byproduct. The waste is sent through a primary gasification chamber, followed by a secondary combustion chamber.

These nonstandard options do not yet efficiently dispose of large numbers of carcasses, are not available in many locations, and/or do not have a large number of units available for use at any given location. However, there is the potential that these technologies could be considered for certain applications (e.g., alkaline hydrolysis for the deactivation of prions). Should these technologies be used during a mass animal health emergency, a risk assessment will be conducted in order to analyze any potential increases in impacts to humans and the environment.

h. Costs of Carcass Management

The cost of the various carcass management options are a factor in choosing from the various alternatives. The management of large numbers of animal carcasses must be cost effective, as well as protective of human health and the environment. Contingency plans must consider the economic costs and the availability of resources for the actual disposal/treatment, as well as numerous related costs.

In 2001, cost estimates for large-scale management of animal carcasses in the United Kingdom exceeded $400 million (McClaskey, 2004). In the 2002 AI outbreaks in Virginia, costs for carcass management were estimated at $149 million; since the 1920s, the 10 multi-flock outbreaks of bird flu in the United States cost the poultry industry $368 million (which does not include increased egg and poultry prices) (Pepin et al., 2014).

i. Transportation

Carcasses must be collected and transported for management before they decompose to the point at which transportation is not feasible. In all situations, carcasses need to be quickly identified, removed from the discovery site (corrals, pens, houses, ranches, etc.), and then transferred to the disposal/treatment site. Onsite transportation collects carcasses from the locations where the animals died and moves them to the onsite disposal location (pit, trench, or composting pile). Offsite disposal options (i.e., rendering, landfills compliant with RCRA, and fixed-facility incinerators compliant with CAA) also require transportation within the premises to collect the carcasses, but then include subsequent movement off of the premises. Transport vehicles must be obtained, personnel must be trained to safely move carcasses, and safe transportation routes must be determined.

For the purpose of this document, a transportation corridor is the route that carcasses, contaminated material, and equipment travel between the carcass discovery site and the final carcass management destination. Between these two endpoints, the carcasses may be held at a staging or holding area, a treatment site, or a temporary disposal area. The route may consist of paths, roads, air space, railways, bridges, and waterways. The route also includes immediately adjacent areas, such as mountains covering a tunnel, canal towpaths, or buildings along a city street because any breach of containment may affect these additional areas.

Transportation corridors must be selected to quickly, safely, and temporarily connect separate carcass management areas. Offsite disposal plans for animal carcasses should include a carefully considered travel route that is as close as possible to the infested site to limit the number of stops (e.g., refueling), and the potential for environmental and human exposure. Consequently, routes may pass through different jurisdictions and cross State lines, through tribal lands, or even across international borders.

The load to be transported may require special permits and there may be a need to prepare a public announcement regarding the transport of the carcasses. All Federal regulations concerning the transportation of carcasses must be followed. The loads may require an escort during transport to guard against tampering. Haulers must be appropriately licensed. Normally, animal carcasses are not classified as hazardous waste or hazardous materials unless the carcasses are contaminated with elevated levels of chemical, biological, or radiological agents. In the case of non-hazardous carcasses, only routine sanitation requirements would apply. Otherwise, the offsite transportation of hazardous wastes is regulated under RCRA. Regulations were developed jointly by EPA (located at 40 CFR part 263) and DOT (located at 49 CFR parts 171179). RCRA requires transporters of hazardous wastes to obtain an EPA identification number, comply with the manifest system (system of forms, reports, and procedures explained at http://www.epa.gov/waste/hazard/transportation/manifest/index.htm), and properly handle hazardous waste discharges (EPA, 2011c).

State and local regulations must also be followed. State regulations and rules may create limitations on intrastate movement. States (e.g., Idaho, Illinois, and Indiana) may require direct movement of carcasses to rendering facilities. Haulers may also be required to have a permit or license, such as in: California, Florida, Georgia, Kansas, Kentucky, Louisiana, Minnesota, and Nebraska. In general, carcasses must be hauled in a sanitary manner, and the vehicles disinfected prior to reuse. Many States require transport to occur in sealed vehicles that do not allow liquids to leak, drip, seep, or drain during movement. Additionally, some States require the carcasses be covered with a tarp or other covering during transport (e.g., Arkansas, Illinois, Iowa, Kentucky, Louisiana, and Nebraska). Removal of carcasses from roadways may be specifically delegated to the State's department of transportation (e.g., California and Georgia). While California identifies entities that can grant waivers for transport requirements during an emergency, most States appear to lack codified requirements for transport of large volumes of animal carcasses during a mass animal health emergency. Therefore, additional planning may be required to meet transport needs during a mass animal health emergency. (See appendix B for a summary of State and Federal regulations.)

If the appropriate procedures are not followed, transportation has the potential to increase the risk of spreading contamination. For example, if carcasses are contaminated with a contagious pathogen (e.g., FMD), the management sites will need to integrate biosecurity practices as part of the complementary security system. If carcasses are not contaminated with an infectious agent, the management sites may not need strict security and biosecurity measures.

Despite the increase in potential biosecurity issues, there are situations when offsite management is not only unavoidable, but desired. Offsite management options use already existing facilities so new management sites are not created. Useful byproducts may be derived from the carcasses. There may be too many animals to bury onsite, wild animals could spread the disease, and human habitation may be too close for onsite options. Environmental conditions, such as a high water table, highly permeable soils, or drought may preclude onsite options because of the potential for significant environmental effects.

j. Decontamination

Decontamination procedures contain the spread of disease during carcass management activities and allow personnel to work safely. Decontamination of personnel and their personal protective equipment prevents human infections by zoonotic pathogens, cross-contamination to healthy animals on the site, and minimizes the risk of transporting the disease agent to other locations. For these reasons, cleaning and disinfection actions during a response become part of the standard operational procedures (SOPs); the methods are updated as the situation changes over time. Particularly for viral diseases that can be spread to remote animals by contact with infected personnel and contaminated equipment, it is essential to clean and disinfect personnel and equipment before they leave an infected site. If items cannot be adequately cleaned and disinfected, they should be disposed of using appropriate methods.

The additional pathogen-dissemination risk associated with transportation may be minimized by proper decontamination procedures and practices. For example, particles contaminated with pathogens may become airborne and then deposited on surfaces and equipment during loading, transport, and off-loading of infected carcasses. Thorough cleaning and disinfection of the transport vehicles after loading and unloading reduces these risks.

Disinfectant manufacturers must register their products with EPA and are, at times, required to provide data showing the product performs as claimed. The label appearing on the product container must be reviewed and approved by EPA. Under the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA), it is unlawful to use a product in a manner inconsistent with its labeling (FIFRA section 12(G)). If the micro-organism appears on the label, applicators may use the product according to label directions. If the micro-organism does not appear on the label, but all other use directions will be followed, it is possible that the disinfectant may still be used under a FIFRA section 2(ee) exemption. However, applicators are advised to check with EPA to confirm this type of use. Applicators may also apply for exemptions for uses that are not approved on the label through a FIFRA section 18 emergency exemption request (see http://www2.epa.gov/pesticide-registration/pesticide-emergency-exemptions for information on section 18 exemptions).

Disinfectants are usually placed in six major groups, including soaps and detergents, oxidizing agents, alkalis, acids, aldehydes, and insecticides (Baird and Savell, 2004). The use of any specific disinfectant depends on the type of disease outbreak that resulted in the need for carcass management (Mukhtar et al., 2008). When specific data is not available, EPA sometimes uses an organism hierarchy to identify effective products for use on emerging pathogens (EPA, 2008). Chemical disinfectants can inactivate most vegetative bacteria and enveloped viruses. Fungal spores and non-enveloped viruses generally are less susceptible to chemical disinfectants. Mycobacteria, bacterial endospores, and protozoal oocysts are highly resistant to most disinfectants (Block, S.S., 2000). Prions are exceptionally resistant to chemical inactivation.

APHIS' SOPs discuss cleaning and disinfection following a FAD outbreak (see http://www.aphis.usda.gov/animal_health/emergency_management/downloads/sop/sop_cd.pdf for the November 2013 draft of the protocol). The SOP discusses the selection of proper disinfectants, methods for applying them, and various other factors to consider while disinfecting. In addition, table 3–4 lists APHIS's regulations regarding disinfection after livestock or carcass removal.

When high-consequence pathogens are not a concern, such as during a mass animal health emergency caused by a natural disaster, State and local regulations concerning decontamination must be followed.

k. Carcass Storage

In some cases, a high mortality loss will require carcasses to be removed from the discovery site, and held in a temporary storage location prior to management. Storage may consist of open air piles, enclosed containers, or refrigeration. The amount of time that carcasses spend in unrefrigerated storage needs to be minimized to avoid or reduce odors, nuisance hazards, and other potential environmental impacts. Temporary unrefrigerated storage locations need to be downwind from surrounding residents and property lines (Mukhtar et al., 2004) to help with odor and nuisance abatement. Preferably, the location is not visible from offsite. Lastly, any uncontained storage sites should be dry (Mukhtar et al., 2004) so that both the rate of decomposition and the risk of potential environmental impacts (e.g., pollution of nearby water sources) prior to management are reduced.

A pile of hazardous carcasses would be regulated by EPA under subtitle C of RCRA as a "waste pile." EPA regulations governing waste piles are found at 40 CFR parts 264 and 265 subpart L. The regulations address analysis, containment, and monitoring of the waste.

Table 3–4. APHIS' Disinfection Regulations.

Program	Means of Disposal	Regulation*
Brucellosis	All premises…and materials, contaminated…by brucellosis reactor or exposed animals shall be properly cleaned and disinfected with a disinfectant permitted by APHIS in accordance with the recommendations of APHIS or State representative…"	9 CFR § 51.8
Scrapie	"When required, cleaning and disinfection shall be conducted under the supervision of a State or APHIS representative…To clean dry surfaces, apply a 2-percent chlorine bleach solution at room temperature….for 1 hour, or apply a 1-molar solution of sodium hydroxide…at room temperature for at least 1 hour…"	9 CFR § 54.7
Chronic Wasting Disease	"…all premises…and all other materials on any premises or conveyances used to house or transport such cervids must be cleaned and disinfected under the supervision of an APHIS employee or a State representative, using methods specified by the APHIS employee or a State representative."	9 CFR § 55.4
Poultry with H5/H7 LPAI	"Cleaning and disinfection must be performed in accordance with the initial State response and containment plan described in § 56.10, which must be approved by APHIS…Apply insecticides and rodenticides immediately after removal of the birds…All premises, conveyances, and materials that came into contact with poultry that were infected with or exposed to H5/H7 LPAI within the premises…After use, equipment used to clean out manure, debris, and feed must be washed, disinfected, and inspected….When cleaning has been completed and all surfaces are dry, all interior surfaces of the structure should be saturated with a disinfectant authorized in § 71.10(a) of this chapter.. *§ *71.10 lists several disinfectants for use, including cresylic disinfectants, liquefied phenol, chlorinated lime, sodium hydroxide, and tuberculocidal disinfectants.*	9 CFR § 56.5

C. Environmental Resources

Environmental components considered within this EIS include a broad range of abiotic and biotic resources. Abiotic resources include land, land use, air, and water; biotic resources include vegetation and wildlife. This section of the EIS considers pertinent features of the soil, water, vegetation, and wildlife in the United States that have the potential to be impacted by the proposed alternatives. The sections on land cover and land use inform the discussion on soil. Soil, air, and water quality may be impacted by carcass management alternatives and, therefore, quality and use issues are also discussed.

All of these resources are influenced by local factors of geography, topography, climate, and demographics. Areas potentially affected during implementation of a carcass management program include agricultural and nonagricultural lands in all States of the United States and its territories. This programmatic document applies to all these areas; consequently, the specifically affected environment and associated impacts are defined only when a program-specific need arises.

Additionally, this section presents a discussion on climate change which includes background information regarding the relationship between climate change and agriculture, as well as CEQ's recommendations for addressing climate change in NEPA documents. The current impact of climate change on the likelihood of mass livestock mortalities will also be discussed.

1. Land Cover and Land Use

According to the Food and Agricultural Organization of the United Nations (FAO), land cover is the observed physical cover on the surface of the Earth as seen from the ground or through remote sensing. It includes vegetation (natural or planted) and human constructions such as buildings and roads (Pasquali et al., 2005). For the purpose of this analysis, the land cover includes farms, farm buildings, carcass management locations or facilities, and roads that lead to offsite disposal facilities. Vehicles loaded with carcasses will pass through other types of land use areas; however, these areas will only briefly become part of the affected environment, unless there are consequences arising from a breach of containment.

Land use refers to the function or the purpose of the land, so it includes activities undertaken to produce goods or services (Pasquali et al., 2005). A given land use occurs on one or more parcels, and each parcel may simultaneously have different uses. The relative proportions of major land uses vary between and within ecoregions. During carcass management, land use on a premise may shift from livestock production to a disposal location if onsite burning, burial, or composting occurs. The major land uses of the affected environment are agriculture (including animal production, pasture and rangeland, crop cultivation, forestry and logging), industrial, housing/residential (including urban, suburban, and rural), recreational, and tourism.

2. Soil Quality

A variety of soil types exist across the United States composing 12 different orders that are further divided into 64 suborders (NRCS, 1999). The smallest unit of classification for soil types is the soil series, which is based on the origin of the soil, and chemical and physical properties. National Resource Conservation Services (NRCS) data exists for more than 20,000 soil series throughout the United States (NRCS, 2014a). Criteria used to separate soil series include soil texture, mineral composition, coarse elements, organic matter, cation exchange capacity, and salt levels. These criteria are used to determine the stability and erosion potential of various soil types, and predict the potential risks to human health and property (NRCS, 2004). Soil type and series information can be used to site landfill facilities, and determine burial and composting locations (Brinton, 2000; Chang et al., 2008; FitzMaurice, 2013).

Soils are affected by naturally occurring events, man-made activities, the local geography, and plant cover. Naturally occurring wind and water erosion can be exacerbated by human activities that affect the soil properties in a given area (NRCS, 2004). Variation in the chemical and physical properties of soil will impact bioavailability, chemical degradation, and transport of naturally occurring and anthropogenic chemicals. The potential for chemical soil contamination and impacts to plants and other biota are also impacted by physical and chemical properties of the soil.

Physical and chemical changes to soil quality occur whenever soil is disturbed. Physical impacts from digging trenches, removing topsoil, and physically compacting soil from the use of heavy equipment may increase erosion and decrease soil quality. Erodible soil types, or soils in sloped areas, may facilitate the movement of soil offsite, creating potential water quality issues and impeding or preventing revegetation (Engel et al., 2004). Decaying materials impact soil quality by releasing chemical contaminants or leachate. Some pollutants, such as nitrogen and phosphorus from carcass leachate, may add minerals and nutrients to the soil that become available for plant growth; however, excessive amounts of these same pollutants can negatively affect native soil micro-organisms and alter normal carbon, nitrogen, and phosphorus cycling. Antibiotics and other chemical and radiological contaminants may leach into soil and affect naturally occurring soil micro-organisms or become available for plant and animal uptake, which may contaminate the food chain

3. Air Quality

Air quality conditions vary across the United States, with urban areas typically experiencing episodes of degraded air quality during certain times of the year. Both Federal and most State agencies monitor air quality.

EPA monitors air quality throughout the country at monitoring stations that measure various pollutants (EPA, 2014d). EPA monitoring generates an air quality index (AQI) for a given area that can be used by the public to determine air quality conditions (EPA, 2014d). The AQI ranges from 0 to 500, with values below 50 suggesting good air quality with no health impacts, while values above 300 suggest poor air quality and potential human health impacts to the entire population. A value of 100 is related to the air quality standard for a given pollutant; values between 100 and 150 may result in potential health impacts to the most sensitive populations. An AQI above 150 represents unhealthy conditions for a larger part of the population, with more impacts as the value increases. Values above 200 are considered rare in the United States. Typical AQI values are below 100 throughout the United States, but may exceed 100 during various times of the year (EPA, 2014d).

The AQI is based on four priority pollutants including sulfur dioxide, carbon monoxide, particulate matter, and ozone. Particulate matter is further divided into particles that are less than 2.5 micrometers (µm) and those less than 10 µm. Other air quality standards are not considered in the estimate of the AQI. Particulate matter and ozone are the main pollutants of concern when there are elevated AQIs (EPA, 2014d). EPA and some State agencies also monitor other pollutants; these may be used to determine if certain areas of the United States are within attainment for priority pollutants as defined by the National Ambient Air Quality Standards (NAAQS) in the CAA.

Areas in the United States where large numbers of livestock occur are typically rural where the AQI is below 50, and are considered as attaining air quality standards. However, these areas may contain large confined animal operations where there is the potential for localized impacts to air quality. The extent of the impact to air quality from these operations depends on the size and management of the facilities. Releases of pollutants from these types of facilities, which may impact air quality, include odorous compounds, micro-organisms, particulate matter, ammonia, nitric oxides, nitrogen oxides, carbon dioxide, methane, and hydrogen sulfide which are commonly grouped together as volatile organic compounds (VOCs) (Aneja et al., 2009; Ni et al., 2009). Some of these pollutants are regulated under Federal or State law and may be managed through compliance agreements between the source and the applicable regulatory entity.

The release of atmospheric pollutants from current carcass management methods varies based on the method employed, and may be regulated by Federal and State regulations and guidance. Many of the air pollutants associated with the operation of large animal operations are also associated with various carcass management practices. Carbon dioxide, ammonia, methane, and other VOCs are associated with onsite burial, composting, and landfills (Yuan et al., 2012; Akdeniz et al., 2011; Hao et al., 2009; Xu et al., 2007; Engel et al., 2004).

4. Water Quality

Ground and surface water in the United States provide a variety of benefits. Based on information from 2005, the United States uses approximately 410,600 million gallons of water per day (Mgal/d); approximately 80 percent is from surface water, and the remaining 20 percent is from ground water (Kenny et al., 2009). Uses vary depending on the location within the United States. Irrigation and thermoelectric power represent one fourth and one half, respectively, of all surface water withdrawals in the United States (Kenny et al., 2009). Two-thirds of ground water withdrawals are for irrigation purposes with Texas, California, Nebraska, and Arkansas responsible for one-half of these withdrawals (Kenny et al., 2009).

Livestock water uses in the United States represent less than 1 percent of the total use from all sources. Approximately 60 percent of the water used for livestock comes from ground water. Livestock water uses include watering, feedlots, dairy operations, cooling of facilities for the animals and animal products such as milk, various on-farm needs, incidental water loss, and animal waste-disposal systems (USGS, 2014). Texas, North Carolina, Nebraska, California, Iowa, and Kansas account for 47 percent of the ground water withdrawals for livestock use, while California, Oklahoma, and Texas represent 37 percent of the surface water withdrawals for this use (USGS, 2014).

The quality of ground and surface water varies across the United States due to a variety of natural and man-made factors. Natural physical and chemical features (e.g., soil type, topography, vegetation type, cover, and mineral levels) can all influence background water quality characteristics for a water body. However, features and activities such as dams, urban development, industrial mining, and agricultural activities can also provide point and non-point sources of contamination that can impact a wide variety of water quality parameters such as pH, temperature, and biological oxygen demand (a measure of the amount of oxygen used by micro-organisms in the oxidation of organic matter). These and similar features and activities can also introduce natural and anthropogenic stressors into ground and surface water impacting water quality. Impacts from excessive nutrients, pathogens, sediments, and other chemicals can degrade water quality impacting both human and ecological health, and the designated use for a specific water body.

Carcasses must not be disposed of in U.S. waters. The Rivers and Harbors Act of 1899, known as the Refuse Act of 1899 (codified at 33 U.S.C. §§ 401–426), makes it unlawful to obstruct navigation or deposit refuse into navigable waters. Section 303(d) of the CWA requires States, territories, and tribes to develop a list of water bodies that are impaired and do not meet current water quality standards. Total maximum daily loads are then developed to meet current water quality standards and restore impaired water bodies. The percentage of assessed water bodies in the United States varies widely based on water body type. One percent of wetlands have been assessed, while greater than 88 percent of the Great Lakes have been assessed. Approximately 29 percent of rivers and streams have been assessed, while approximately 43 percent of lakes have been assessed (EPA, 2014e).

Reasons for water quality impairment fall within approximately 34 different groups; however, current CWA section 303(d) listings for all States show that the primary reasons for impairment (in decreasing order) are pathogens, nutrients, metals, organic enrichment, and sediments. This group represents approximately 38 percent of the total causes for impairment of assessed water bodies in the United States (EPA, 2014e). Within the pathogen group, fecal coliforms and *E. coli* are the primary causal agents for impairment due to pathogens. Nutrient impairment is primarily due to excessive phosphorus and total nitrogen in water.

Agriculture is the primary cause of impairment to rivers and streams, is the third leading cause of impairment for lakes, and is the second leading cause for impairment for wetlands (EPA, 2014e). Agriculture includes multiple aspects of the industry, including crop and livestock production. Livestock sources may include grazing, confined animal feeding operations, animal manure, and other activities (EPA, 2014e).

Several water pollutants are identified below as potential threats to ground and surface water as a result of carcass management:

- antibiotics
- ash
- chloride
- dioxins, polycyclic aromatic hydrocarbons, and other combustion byproducts,
- hormones
- metals
- micro-organisms (including pathogens)
- nitrogen-containing compounds (ammonia and nitrate)
- oils and grease
- pharmaceutical drugs (various veterinary uses such as euthanasia)
- phosphorous
- sulfates
- total dissolved solids
- total organic carbon
  (Yuan et al., 2013; Joung et al., 2013; Pratt and Fonstad, 2009; Glanville et al., 2006; Engel et al., 2004; Myers et al., 1999; Ritter and Chirnside, 1995).

Some of these contaminants are detected in leachate from swine, cattle, and poultry disposal, while the presence of others such as antibiotics, pathogenic micro-organisms, and veterinarian pharmaceuticals reflect the specific source or industry. Many of these pollutants are also listed as causal agents for impairment under section 303(d) for various water bodies in the United States. Aerial deposition, as well as leaching or runoff, may be pathways for pollutants to enter surface and ground water sources from burning activities (Pollard et al., 2008).

5. Vegetation

Various carcass management activities will impact vegetation and, specifically, could increase the presence of exotic invasive plant species. Vegetation is a key component of a functioning ecosystem because plants respond to and change their environments, actively altering soil stability, affecting nutrient and water availability, influencing the distribution of pests and beneficial organisms, and determining the soil biota (Schulze and Mooney, 1994). Plant cover reduces erosion and protects soil against degradation, consequently removal of plant cover impacts ecosystem function and future land use (Castillo et al., 1997; Zhao et al., 2011).

Exotic invasive species represent one of the greatest threats to rangelands by degrading ecosystem productivity and reducing biodiversity (Mullin et al., 2000). Biodiversity describes the variety of plant, animal, and microbial life found within an ecosystem, and is important for a variety of reasons, such as communities with a greater number of plant species are more resistant to drought (Loreau et al., 2002). Establishment of exotic invasive plants reduces the number of different plant species simplifying the native plant community. This is because invasive plant species can outcompete native species, and change nutrients and water cycling patterns (Sands et al., 2009). Reductions in biodiversity may lead to long-term or irreversible habitat degradation through this disruption of nutrient cycling and soil stability (Sands et al., 2009).

While agriculture depends on a wide variety of native and nonnative species, areas not under cultivation depend on the presence of diverse communities of native plants (Mullin et al., 2000). Invasive plant species within agricultural cropland ecosystems are known as weeds, and their control costs (for fuel, equipment, labor) exceed expenditures for the combined control of insect, rodent, and disease pests (Mullin et al., 2000).

Plants serve as food sources for various animals. Many types of vegetation in an area provide habitat for wildlife, and attract animals that eat insects. The high prevalence of nonnative species in Northeastern pasture lands was contrasted with Western grasslands that generally consisted of native herbaceous species; the species richness values were similar suggesting that neither fundamental characteristics of grassland plants nor grazed communities places a limit on species richness (Tracy and Sanderson, 2000).

6. Wildlife

Wildlife inhabits the environment where carcass management activities occur. Wildlife may feed on carcasses and become affected by the presence of carcasses. To minimize transmission of pathogens, it is important to manage carcasses within a short time after discovery in order to decrease the amount of time that scavengers (e.g., eagles, vultures, crows, foxes, bears, martens and fishers, coyotes, lynx, bobcats, and mountain lions) can feed on carcasses.

Bald and golden eagles locate fresh carcasses quickly, which makes them susceptible to secondary poisoning when animals are euthanized with toxins and left uncovered. While bald and golden eagles are most commonly affected by veterinary drugs, other birds, including vultures, crows, ravens, magpies, wood storks, martens and fishers, and California condors may also scavenge and be impacted by pentobarbital. Scavenging mammals, such as foxes, bears, coyotes, lynx, bobcats, and mountain lions could be affected by ingestion of pentobarbital (Krueger and Krueger, n.d.).

While no wildlife deaths were documented, pentobarbital was documented as the cause of death for domestic dogs that consumed exposed carcasses. In 2010, two dogs were poisoned by pentobarbital as a result of eating the unburied carcass of a horse that had been euthanized 2 years earlier, and it is likely that two of the horse owner's dogs also were killed after consuming the horse carcass. While no wildlife carcasses were discovered, it is possible that if any wildlife species were killed by this horse carcass, they were dragged away by scavengers (Kaiser et al., 2010). The U.S. Fish and Wildlife Service (FWS) and National Euthanasia Registry recommend that animals treated with pentobarbital are either buried or burned shortly after death (Krueger and Krueger, n.d.; Lazaroff, 2002).

The United States banned the use of lead pellets for hunting waterfowl in 1991, and this has reduced lead levels and poisoning in waterfowl (Anderson et al., 2000); however, lead poisoning remains a hazard to wildlife. Even though nontoxic shot requirements were established for hunting waterfowl in 1991, lead is still used in ammunition for upland hunting, shooting sports, euthanizing livestock, and in fishing tackle. The use of lead in ammunition exposes upland game birds (e.g., doves and quail) and scavenging birds (e.g., vultures and eagles) to this toxin. Lead poisoning is a slow-acting disease that causes behavioral, physiological, and biochemical effects that can result in death (USGS, 2013).

D. Human Health and Safety

The various carcass management alternatives used during mass animal health emergencies have the potential to pose risks to human health and safety, at various levels, and to a wide range of people. First, when managing carcasses, there is the risk to humans associated with direct exposure to the source of the emergency (e.g., pathogens, natural disasters, chemical/radiological hazards, etc.). Second, failure to properly manage carcasses creates the potential for indirect exposure to harm. For example, there is the potential for vectors, such as flies and rats, to spread pathogens to humans from decomposing carcasses. Third, there are human health and safety risks associated with the various carcass management options. For example there are risks related to the process itself, such as working around heavy equipment used for handling carcasses; from heat-related injuries of burning, incineration, and rendering; and hazards from disinfection and/or biosecurity (if there is a breach during transportation) risks. Lastly, there may be a psychological and emotional element involved with mass depopulation and disposal.

In a natural disaster, humans need to clean debris and rebuild damaged infrastructure, in addition to coping with the carcasses. During a chemical, radiological, or nuclear incident, human casualties are handles separately by the human health care system. Nevertheless, detection of contamination by chemical or radiological agents is critical to determine if responders need to adopt special precautions to minimize human contact with the source of the mass animal health emergency. If animal feed is accidentally contaminated with a toxic chemical, the exposed animals are no longer suitable for consumption and must be euthanized. Throughout any of these incidents, veterinarians and livestock owners are likely to divide their energies between meeting personal and humanitarian needs, and coping with the mass animal health emergency.

The source of a mass animal health emergency, such as zoonotic agents, may simultaneously impact human health and safety. Zoonotic agents may be bacterial, viral, parasitic, or fungal, or may involve unconventional agents, such as prions (WHO, 2013). According to the CDC, approximately 75 percent of new emerging human infectious diseases are of animal origin, and approximately 60 percent of all human pathogens are zoonotic (CDC, 2014). Zoonotic agents that cause a mass animal emergency can be FADs or endemic in the United States. Although FADs (e.g., ASF, CSF, and FMD) can pose a severe threat to U.S. animal health, these diseases are not public health concerns because humans are not susceptible to ASF or CSF; human infection with FMDv is rare, and symptoms of the disease are generally mild, short-lived, and self-limiting (CFSPH, 2014). Table 3–5 provides examples of zoonoses that can be transmitted to humans from animal carcasses, summarized by various zoonotic agents.

As carcasses degrade, leachate is released into the environment and can directly affect the health and safety of surrounding humans. Leachate samples collected from a closed, covered, 5- to 15-year old landfill had normal microbial flora of *Aeronomas hydrophila*, *A. sobria, Bacillus thuringiensis, Brevundimonas diminuta, Chryseobacterium indologenes, Corynebacterium lucuronolyticum, Nocardia otitidiscaviarum, Pseudomonas aeruginosa*, and *P. putida* that supported survival of inoculated *Bacillus anthracis* (causes anthrax) cultures for 24 weeks; *Clostridium botulinum* (responsible for foodborne botulism) for 22 weeks; and non-spore-forming *Yersinia pestis* (responsible for bubonic plague) and *Francisella tularensis* for less than 7 weeks (Davis-Hoover et al., 2006).

The ability of pathogen populations to survive in leachate demonstrates the need for leachate movement to be controlled, and suggests minimal durations for pathogen risk during disposal that generates leachate. Nevertheless, the concentrations of *E. coli* and *Cryptosporidium* in ground and surface waters were affected to a greater extent by excretion from live animals than from the burial of a small number of carcasses (Gwyther et al., 2011).

Table 3–5. Examples of Zoonotic Diseases.

Disease	Zoonotic Agent	Affected Animals	Transmission to Humans	Human Effects
Avian Influenza	Virus	Poultry; birds	Direct or indirect contact with dead animals (e.g., Asian lineage H5N1 (HPAI) viruses)	Conjunctivitis or mild respiratory disease, some viral strains cause severe disease and death.
Brucellosis	Bacteria (*Brucella* spp.)	Cattle, bison, buffalo, and elk	Contact with animals, animal products, or bacteria-contaminated carcasses	Acute febrile illness with nonspecific flu-like signs such as fever, headache, malaise, back pain, myalgia and generalized aches. Drenching sweats can occur.
Anthrax	Spore-forming bacteria (*Bacillus anthracis*)	Most mammals; several bird species	Direct contact with infected animals or their products (e.g., blood, wool, or hide) when there is a break or abrasion in the skin; biting flies	Severe illness in humans affecting the gastrointestinal and respiratory tracts. Anthrax is rare in the U.S. because of yearly vaccination of livestock in areas where previously detected (CDC, 2014).
Bovine Spongiform Encephalopathy	Prion	Cattle	Consumption of meat contaminated with prions	Variant Creutzfeldt-Jakob disease-a rare and fatal human neurodegenerative condition causing spongy degeneration of the brain.

(Source: WHO, 2013 and CFSPH, 2014)

Improper carcass management leading to contamination of water supplies with biological, chemical, and/or radiological agents presents a health risk to human populations that use the contaminated water body for drinking, bathing, and cleaning. Existing laws and practices are designed to minimize impacts to water resources and, consequently, decrease the likelihood of human exposure to contaminated water.

Transient wildlife may disseminate contaminants to nearby livestock or humans. The source of the emergency (e.g., biological, chemical, and/or radiological agents) may become wind- and/or water-borne, and place human populations at risk from the nearby hazards making it prudent to require some level of carcass management activities for these areas.

The human health and safety risks associated with each disposal method arise from exposure to pathogens, workplace hazards associated with the equipment, and hazardous materials used or produced during processing. Each disposal method is associated with the production of some level of noise, either through the equipment as it operates, or during loading and off-loading of the carcasses. During normal operations for routine mortalities, these noise levels are expected to be within existing standards for occupational exposure.

Human health risks also include the potential for psychological harm arising from coping with the extremely unpleasant odors and sight of animal remains. In short, carcass management operations are permeated with odors. The primary odor is the smell of decaying animal flesh which causes revulsion in most humans. To a certain extent, the human nose becomes desensitized during extended exposure to any smell, therefore acute distress is likely to be felt by workers only from time to time. Passersby are likely to avoid the smells by leaving the area and closing vehicle windows. People residing downwind from a carcass management operation are not likely to be able to avoid periodic wafting odors.

Site safety is a key factor to prevent the spread of disease and contamination. If carcasses are contaminated with a contagious pathogen, (e.g., FMDv or prions), the carcass management site(s) will need biosecurity practices as part of the security system. If carcasses are contaminated with a non-infectious agent, the site(s) may not need strict security and biosecurity measures.

E. Climate Change

Climate change represents a statistical change in global climate conditions, including shifts in the frequency of extreme weather (Cook et al., 2008). In 2012, agriculture contributed an estimated 8.1 percent of all greenhouse gas (GHG) emissions in the United States. The global warming potential of GHGs is measured against the reference gas carbon dioxide, and is reported as teragrams (millions of metric tons) of carbon dioxide. EPA identifies carbon dioxide, methane, and nitrous oxide as the key GHGs affecting climate change (EPA, 2011d); however agricultural activities primarily contribute methane and nitrous oxide (EPA, 2014f). GHGs are emitted from natural processes and human activities that trap heat in the atmosphere. While GHGs help regulate the Earth's temperature, they also contribute to global climate change.

Agricultural practices are associated with the production and sequestration of GHGs. Agricultural sources of methane emissions are associated primarily with emissions of gas from cattle and nonruminant animals, and manure management (du Toit, 2013). Emissions of other GHGs are released primarily during the use of agricultural equipment (e.g., irrigation pumps and tractors), and include carbon monoxide, nitrogen oxides, reactive organic gases, particulate matter, and sulfur oxides (EPA, 2011d). Additional emissions arise from the production and delivery of fuels to farms (West and Marland, 2002). Disruption and exposure of soil also promotes carbon dioxide production by the oxidation of soil organic matter (Baker et al., 2005).

Climate change-induced drought is expected to increase in severity and frequency, even though drought frequency did not substantially change over the last 60 years (Grigg, 2014). At the present time, climate change is generally making it more difficult to produce crops and raise livestock because of uncertainty associated with the availability of water. Early season droughts and temperature extremes can interfere with the supplies of water needed to sustain healthy animal populations. Heat waves, which are projected to increase under climate change, could directly threaten livestock, increase vulnerability to animal disease, or cause animal losses (USGCRP, 2009). If mortalities of this type occur, large cattle operations in Western and Midwestern States appear likely to become the most concerned with carcass management (figure 3–18).

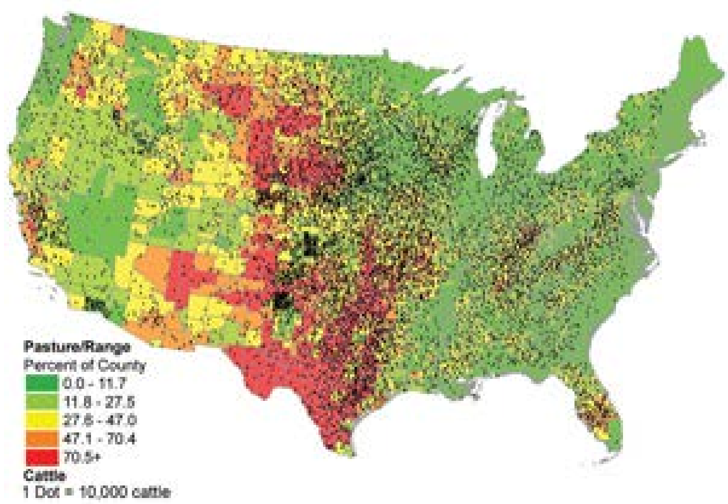

Figure 3–18. Beef cattle and pasture distribution in the United States (Source: USGCRP, 2009. Available: http://www.epa.gov/climatechange/impacts-adaptation/agriculture.html)

CEQ advises that agencies assess the potential for a proposed action to impact climate change if the action may cause 25,000 metric tons or more of carbon dioxide-equivalent GHGs per year to be emitted. CEQ also encourages Federal agencies to consider whether the action’s long-term emissions should receive similar analysis, even if the annual direct emissions of carbon dioxide-equivalent GHGs are less than 25,000 metric tons (CEQ, 2010). This serves as a baseline for the minimum level of GHG emissions from an action that may warrant further discussion in the NEPA analysis.

Weather extremes, even if not responsible for the mass animal health emergency, do affect the speed of carcass management operations. Maneuvering carcasses into vehicles can be hampered by rain, and vehicles can become stuck in mud. Workers need to take sufficient breaks when ambient temperatures are uncomfortably high. Emergency planning must allow ample resources to address these needs, should they arise.

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IV. Potential Environmental Impacts

This chapter discusses and compares the potential environmental effects associated with the alternatives including no action, standard procedures, and adaptive management.

- The no action alternative includes unlined burial and open-air burning disposal options.

- The standard procedures alternative includes unlined burial, open-air burning, composting, rendering, landfills compliant with the Resource, Conservation, and Recovery Act (RCRA), and/or fixed-facility incineration compliant with the Clean Air Act (CAA).

- Adaptive management includes all disposal options listed under the standard procedures alternative, as well as any other nonstandard options that would pose the same or fewer environmental impacts.

The relevant carcass management issues that will be discussed and, when appropriate, compared for each alternative include soil quality, air quality, water quality, vegetation, humans, livestock, wildlife (including endangered species), climate change, and cumulative impacts.

While the no action and standard option alternatives are addressed for each carcass management issue, the adaptive management alternative is discussed separately; this organization reduces repetition and attempts to clarify the impacts. When appropriate, impacts that are common to all the alternatives and potential mitigations for the alternatives are also discussed for each carcass management issue. In addition, rather than repeat similar impact discussions regarding disinfection, transportation, and lead (exposure via ammunition if animal is euthanized) under various alternatives, separate sections for these topics were created.

This chapter describes the potential worst-case environmental impacts from carcass management during a mass animal health emergency due to natural disasters, disease (primarily FADs), and chemical and/or radiological contamination. Following the appropriate Federal or State regulations, guidance, or best management practices (BMPs) reduces impacts to the environment. Mitigations, which can vary from not using a certain management option to simply moving a management site, can significantly alter impacts.

As previously mentioned, the goals of carcass management are to use the most timely, safest, environmentally responsible, and cost-effective methods available. When these criteria lead to conflicting choices, effective carcass management develops the BMPs to fit each situation.

Biosecurity concerns, especially in instances of zoonotic disease, can outweigh most other concerns. Therefore, if livestock death is due to a contagious disease, then one of the priorities is to find a solution that restores biosecurity in order to protect both human and livestock health. If, instead, deaths are due to a natural disaster, then a greater emphasis might be placed on managing carcasses in an environmentally friendly solution. Each situation will have different risks to consider and evaluate.

A. Adaptive Management Alternative

Both the standard procedures and nonstandard options could be used under the adaptive management alternative. The potential environmental impacts of the standard procedures alternative are discussed under the standard procedures sections within this chapter; however, those impacts are also applicable to the adaptive management alternative. The potential environmental impacts of any nonstandard options will be analyzed just before the time of use within a separate risk assessment, and then considered and discussed within a site-specific EA. If the risk assessment indicates the risks to human health and the environment are equal or fewer than the risks identified in the no action or standard procedures alternatives, then the nonstandard option may be used. The adaptive management alternative would not use any carcass management options that result in greater impacts to soil, air, water, vegetation quality, or to human or animal health than the no action or standard procedures alternatives without updating or supplementing this EIS.

The adaptive management alternative provides the greatest flexibility in carcass management. Program decisionmakers can consider and potentially use any disposal technologies present at or near the location of the animal health emergency. APHIS recognizes the use of nonstandard options in a mass animal health emergency would be rare, if at all. It is unreasonable to attempt to consider all nonstandard technology that exists or will exist in the future. Currently, nonstandard options are probably not capable of treating or disposing of large numbers of carcasses, either because the technologies are not yet efficient, or there simply are not enough units available. However, should there be a change in the efficiency, number, or range of nonstandard technologies, it is imperative that decisionmakers have the ability to quickly identify these carcass management options, analyze their risks, and implement their use.

B. Soil Quality

1. No Action Alternative

Under the no action alternative, the potential for impacts to soil quality are expected to be greater than those found in the standard procedures alternative. This is because the byproducts of unlined burial and open-air burning are not contained and have a greater chance of migrating to nearby soils.

Onsite unlined burial and open-air burning would contribute to chemical and physical impacts to the soil, primarily in the immediate area where unlined burial or open-air burning occurs. The significance of these impacts would vary based on whether this alternative is selected as a means of managing carcasses from a natural disaster, disease outbreak, or a chemical/radiological release. Carcasses that contain biological, chemical, and/or radiological agents could result in significant onsite soil contamination that would impact the future use of the land, and also impact livestock, wildlife and human health. The ability to manage biological-, chemical- and/or radiological-contaminated carcasses using onsite burial or open-air burning will be dependent upon the type and level of contamination, as well as Federal and State regulations regarding disposal of hazardous waste. Federal and State regulations may prohibit the use of onsite unlined burial or open-air burning of carcasses containing biological, chemical, and/or radiological agents due to potential environmental and human health concerns.

a. Unlined Burial

Onsite unlined burial will impact the physical properties of soil by using heavy machinery to dig trenches and remove topsoil. Compaction may result in increased soil-bulk density values (the dry weight of the soil divided by the total volume the soil occupies) that may decrease revegetation rates of burial sites. These physical impacts to soil may result in increased erosion during and after burial activities have occurred.

Disposal of carcasses in unlined burial trenches allows any biological, chemical, and radiological agents that may be present to leach into the surrounding soil. The impact of these agents on soil quality is dependent on the type of agent, its concentration, ability to degrade, and binding potential to soil particles. Elevated levels of phosphorus, nitrogen, chloride, antibiotics, hormones, and veterinarian pharmaceuticals have been observed in soils surrounding unlined burial pits.

In the case of phosphorus- and nitrogen-containing compounds, impacts to surface soil quality may be beneficial; however, excess levels may limit plant growth. The contribution of these pollutants to soils may also alter naturally occurring soil micro-organisms responsible for cycling phosphorus and nitrogen in soils (Pratt and Fonstad, 2009).

Antibiotics found in degrading buried carcasses may impact soil quality due to the toxicity of these compounds to micro-organisms. Antibiotics tend to bind to soil, thereby reducing availability for uptake by plants or other organisms. Their degradation half-lives range from a few days to years, depending on the type of antibiotics and the environmental conditions (Lee et al., 2007). Antibiotics are toxic to various micro-organisms resulting in impacts to overall soil functions, such as soil nitrification and organic matter degradation in soil (Lee et al., 2007).

b. Open-Air Burning

The use of heavy machinery during pyre establishment and burning could compact soil. There may also be physical and chemical impacts to soil quality due to the extreme temperatures generated during combustion (Knicker, 2007).

Contaminants present in the soil after onsite open-air burning may be similar to those existing after onsite unlined burial; however, organic chemicals such as hormones, antibiotics, and veterinary pharmaceuticals are likely to be degraded during combustion. The complete breakdown of these types of chemicals is dependent upon the combustion efficiency during open-air burning. Combustion efficiency would also be an important factor in ensuring destruction of pathogens when carcasses are contaminated. The combustion efficiency is expected to be less for open-air burning than for a fixed-facility incinerator (Mukhtar et al., 2008).

2. Standard Procedures Alternative

The standard procedures alternative provides additional carcass management options that would reduce the potential for impacts to soil quality. Offsite rendering, incineration, and landfilling are conducted at permitted facilities with controls meant to protect the environment, and would be expected to result in less of an impact to soil than unlined burial or onsite open-air burning. The release of chemicals from offsite facilities (i.e., rendering, incineration, and landfill facilities) are typically regulated through a Federal or State permitting process. In addition, the controlled environments of offsite facilities are more effective in processing pollutants, compared to unlined burial and open-air burning. If an offsite facility already exists, that reduces the need for soil disturbance, and resulting potential for erosion, compared to onsite management options. When composting is conducted properly by certified personnel, less impacts are expected from the standard procedures alternative than the no action alternative.

a. Rendering

There are some releases of VOCs from rendering facilities. VOCs released into the atmosphere and deposited on soil are subject to abiotic and biotic degradation that will vary based on site conditions and the type of VOC (EPA, 1993). However, due to the environmental fate of VOCs, and the Federal and State regulations of these releases, significant impacts to soil quality are not anticipated. The use of rendering or the manner in which the byproducts of rendering are disposed of may be limited if carcasses contain certain pathogens, chemicals, or radiological agents.

b. Fixed-Facility Incineration

The potential impacts of incineration on soil are expected to be similar whether disposing of carcasses due to a disease outbreak or during a mass animal health emergency because of a natural disaster. VOCs are released from incineration facilities; their fate is described above for rendering facilities. Additionally, multiple pollutants (e.g., particulate matter, dioxins, polyaromatic hydrocarbons, and metals) are released into the air during incineration of carcasses, and may be deposited on soil (Engel et al., 2004; Chen et al., 2004, Chen et al., 2003a, Chen et al., 2003b). These pollutants would be subject to abiotic and biotic degradation, depending on the site conditions and the type of pollutant. The extent of any soil impacts from fixed-facility incineration would be based on the number of carcasses being incinerated, as well as any Federal or State regulations that control air pollutants from these types of facilities. The impacts to soil quality would be negligible from fixed-facility incineration as disposal would be part of routine activities that already occur at the facility.

Reported levels of dioxin during the FMD outbreak in the United Kingdom suggest dioxin levels in soil during incineration of carcasses in the United States would be similar to control areas and, subsequently, not be a human health concern (Engel et al., 2004). Large organic compounds (e.g., dioxins and polyaromatic hydrocarbons) would be subject to binding to the soil, as well as biotic and abiotic degradation. Ash produced from incineration may require disposal at a landfill or, in cases where biological, chemical, and/or radiological contamination is not an issue, the ash can be applied to land. The impact to soil quality from land application of ash will benefit mineral and nutrient levels; however, excess land application of ash may inhibit plant growth, and could result in the movement of minerals and nutrients offsite to aquatic systems. Federal and State recommendations are available regarding the use of incinerators and disposal of ash to fields or to trash disposal systems (NRCS, 2009).

Incinerators are capable of destroying pathogens, including prions (APHIS, 2012a). However, there is the potential for an increase in impacts to soil quality when incinerating carcasses contaminated with chemical or radiological agents. Toxic chemical agents would vary in their potential to be released into the atmosphere and deposited onto the surrounding soil. Organic chemicals are likely to be destroyed during the incineration process. Inorganic chemicals, such as metals, would not be prone to destruction, and could be released into the air and eventually accumulate in the soil. Some metals may bind to soil, reducing their availability for uptake by plants or other organisms.

Due to recent releases from Chernobyl, Fukushima, and nuclear weapons testing, the incineration of carcasses containing radiological agents is likely to involve radioactive cesium. Radioactive cesium could be a primary byproduct released from many radiation-related activities, including dirty bombs. Radiocesium sublimes (become gaseous) at around 2192 °F (1200 °C) and may also be present in solid form after incineration. It could be deposited on soil resulting in contamination and potential uptake by plants, which could have human health implications (Cook et al., 2007). Potential radioactive cesium accumulation in terrestrial and aquatic organisms from soil is dependent on site-specific physical and chemical conditions that will affect the chemical behavior of cesium (Avery, 1996).

Fixed-facility incineration should not be permitted in cases where radiological agents are present, and may not be permitted in cases where complete destruction of biological and chemical agents is not possible.

c. Composting

Onsite composting of carcasses during or after a natural disaster and some disease outbreaks would result in physical and chemical changes to soil quality, in particular to those areas where the composted material would be applied. The changes to soil quality may be beneficial by providing nutrients and minerals that would increase crop yield and plant growth; however, excess nutrients in the soil may be harmful to plants. Nutrients may be susceptible to moving offsite as runoff. Federal and State guidelines provide recommendations regarding the application of compost to fields designed to minimize the potential for nutrients to move offsite (NRCS, 2003a). In addition, when barriers are not placed under compost piles, nutrients may impact soil quality.

Composting can be an effective means of destroying some pathogens, such as viruses and non-spore-forming bacteria; however, it may not be effective for other pathogens, such as those related to prions (Mukhtar et al., 2008). Composting carcasses contaminated with prion- or spore-forming bacteria may result in pathogen contamination of soil where composting occurs, as well as soil where the composted material is applied as an amendment. Carcasses that are contaminated with chemical or radiological agents or certain biological agents should not be composted because these types of contaminants may not be susceptible to inactivation, dilution, or degradation and could contaminate soil.

Assuming composting, including land application of composted material, is done according to site-specific soil characteristics and guidance from Federal and State agencies, the disposal option should have less impacts to soil quality than unlined burial (Glanville, 2009). Material may be placed on an impermeable or semipermiable barrier during composting and is monitored; therefore, leachate is less likely than unlined burial to contaminate the surrounding soil.

Composting is also expected to have less of an impact on soil quality when compared to open-air burning. Open-air burning releases pollutants related to combustion (ex. particulate matter, smoke, etc.) and may emit contaminants related to incomplete combustion. These pollutants can land on the surrounding soil. Composting would not result in the release of pollutants related to combustion. Composting can release some VOCs; however, these are expected to be minimal under proper composting management guidelines.

d. Landfill

Offsite landfill disposal of carcasses could result in physical and chemical impacts to soil; however, these types of impacts would be negligible when facilities are compliant with RCRA. When facilities are compliant with RCRA, they are managed to prevent leachate release and airborne deposition of chemicals to surrounding soils. In addition, landfills are already highly disturbed areas from other routine disposal activities.

3. Impacts Common to All Alternatives

There is the potential for temporarily piled carcasses to have soil impacts. If carcasses are not processed immediately, meaning they are not moved directly from the discovery site to the final disposal location, leachate from temporarily piled carcasses could impact the soil quality directly under and within the immediate area of the piles. This onsite impact could also occur at designated facilities for rendering, incineration, and landfill if carcasses are piled onto soil prior to processing.

C. Air Quality

1. No Action Alternative

Under the no action alternative, the potential impacts to air quality are greater than those found in the standard procedures alternative. This is because the byproducts of unlined burial and open-air burning are not controlled and may be dispersed into the air. However, air quality impacts associated with unlined burial are likely to be less than open-air burning.

a. Unlined Burial

The potential impacts to air quality from the unlined burial of carcasses would vary based on how the site is managed and whether the carcasses are contaminated with biological, chemical, and/or radiological agents. Unlined burial of carcasses may release gases associated with anaerobic decomposition, such as carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, hydrogen chloride and fluoride, and methane (Engel et al., 2004; Yuan et al., 2012). These gases can build up and result in a rupture of the cover used during carcass disposal procedures. Proper venting and subsequent monitoring of the burial sites would reduce the likelihood of any rupturing at the site. These gases may also vent through the soil, impacting plant growth; potentially accumulate in enclosed underground spaces such as basements, resulting in explosion hazards; and, potentially exceed air quality standards or worker exposure limits.

There are additional potential impacts to air quality that may occur when burying carcasses containing biological, chemical, and/or radiological agents. With the burial of carcasses containing disease, there is a potential for pathogens to be discharged into the atmosphere if the burial site accumulates gases, resulting in the forceful rupture of cover soils. Proper burial techniques (e.g., venting burial sites) would reduce this likelihood. Most nonvolatile organic chemicals and metals, with the exception of certain nobel gases (a group of rare gases that includes helium, neon, argon, krypton, xenon, and radon), however, including radiological agents, are not expected to dissipate into the atmosphere; these would be more likely to partition to soil or water. Volatile chemicals or degradation products of organic chemicals may dissipate into the atmosphere and impact air quality.

b. Open-Air Burning

The potential impacts to air quality from open-air burning include odor, smoke, and other pollutants that are byproducts of combustion. Some of the pollutants include particulate matter, dioxins, polyaromatic hydrocarbons, metals, and other pollutants that are released into the air during carcass burning activities (Engel et al., 2004; Chen et al., 2004; Chen et al., 2003a; Chen et al., 2003b).

There are additional potential impacts to air when the carcasses are contaminated with biological, chemical, and/or radiological agents. While open-air burning has been used successfully in previous disease-related outbreaks, such as FMD and anthrax (Scudamore et al., 2002; Wafula et al., 2008), pathogens may be released into the atmosphere and become dispersed during combustion. The potential risk for dispersion of most pathogens as a result of open-air burning is expected to be low; however, in cases where incomplete combustion occurs and more heat-resistant pathogens (e.g., prions) are present, the risk could increase (Brown et al., 2004).

Open-air burning of carcasses contaminated with chemical or radiological agents may impact air quality through the release of contaminants, or their combustion byproducts, into the atmosphere. The ability of chemical and radiological agents to disperse into the atmosphere from open-air burning will depend on the specific characteristics of the chemical or radiological agent, and the efficacy of combustion during open-air burning activities. Combustion and degradation of most organic chemicals would be expected during open-air burning; however, combustion and degradation of heavy metals and radiological agents may not occur, and these contaminants could be discharged into the atmosphere (Brekke et al., 1985; Chen et al., 2004).

Federal and State regulations may prohibit the disposal of carcasses using open-air burning, reducing the potential that biological, chemical, and/or radiological agents may be released into the air. Potential mitigations include constructing shallow trenches below pyres to promote clean combustion (Kastner and Phebus, 2004), and allow an adequate air supply to maintain the needed temperature.

2. Standard Procedures Alternative

The impacts to air quality from the selection of the standard procedures alternative are expected to result in fewer impacts than under the no action alternative. This is because the air emissions from rendering, fixed-facility, incineration, and landfilling are regulated through a Federal or State permitting process to minimize releases. The controlled environments of these offsite facilities are more effective in processing or containing carcasses and associated pollutants, compared to the no action alternative. In addition, air emissions from composting are expected to be minimal.

a. Rendering

Odors and VOCs released from rendering facilities may impact air quality. However, rendering plants have various ways of controlling nuisance odors (Sindt, 2006). Emissions from rendering facilities are regulated at the Federal and State levels, depending on the type and size of rendering facility.

Rendering carcasses contaminated with a biological or chemical agent could produce additional impacts. The risk of the release of pathogens (e.g., viruses and bacteria) from contaminated carcasses is negligible; however, there is a slight increase in the risk of releasing prions into the air (Hamilton et al., 2006). VOCs may be released into the atmosphere, as well.

b. Fixed-Facility Incineration

Pollutants, such as particulate matter, dioxins, polyaromatic hydrocarbons, metals, and other chemicals are released during the incineration of carcasses (Engel et al., 2004; Chen et al., 2004; Chen et al., 2003a; Chen et al., 2003b). Organic chemicals are likely to be destroyed during the incineration process. Inorganic chemicals, such as metals, would not be prone to destruction and could be released into the air. In cases when carcasses are contaminated with radiological materials, such as radioactive cesium, the contaminants may be discharged into the atmosphere. Therefore, fixed-facility incineration should not be permitted. The amount of pollutants released is expected to be less than during open-air burning as that disposal option may not be regulated, and the combustion efficacy is more difficult to manage. Emissions at incineration facilities are regulated under Federal and State permits, thereby reducing the potential for significant impacts to air quality.

c. Composting

Odors and VOCs released from composting may impact air quality. Composting releases carbon dioxide, ammonia, methane, and other VOCs (Akdinez et al., 2011; Akdinez et al., 2010; Hao et al., 2009; Xu et al., 2007). Impacts to air quality, such as odor, can be reduced by effective composting measures.

There may be a potential increase in impacts to air when composting carcasses contaminated with biological, chemical, and/or radiological agents. Composting has been shown to be an effective means of destroying some pathogens, such as viruses and non-spore-forming bacteria; however, it may not be effective for others, such as those related to prions (Mukhtar et al., 2008). Composting of carcasses that are contaminated with chemical or radiological agents would not be expected to result in significant impacts to air quality unless the chemical or degradation products are volatile. There is the potential for the emission of some chemicals or radiological agents into the air when agents (e.g., radioactive cesium) partition onto small particulate matter that could become resuspended during composting activities.

Assuming composting (including land application of composted material) is done according to site-specific soil characteristics and guidance from Federal and State agencies, composting should have less impacts to air quality than open-air burning. Open-air burning releases pollutants from combustion (e.g., particulate matter, smoke, etc.) and potential contaminants related to incomplete combustion. Composting would not result in the release of pollutants related to combustion. Composting can release some volatile organic compounds; however, these are expected to be minimal under proper composting management guidelines.

d. Landfill

Disposal of carcasses in landfills is expected to result in similar impacts to air quality as composting. Offsite landfill disposal of carcasses can result in the release of gases, such as ammonia and methane, as well as other volatile compounds that are byproducts of decomposition (Yuan et al., 2012). Carcass disposal at landfills would occur in those that are designed to manage gases through capture, flaring, or filtering, thereby reducing release to the atmosphere.

D. Water Quality

1. No Action Alternative

Under the no action alternative, the potential impacts to water quality are expected to be greater than those found in the standard procedure and adaptive management alternatives. This is because the byproducts of unlined burial and open-air burning are not contained and, as such, have a greater chance of being transported to surrounding water sources. However, the potential for impacts to surface and ground water from carcass disposal activities is greater for unlined burial than open-air burning.

a. Unlined Burial

The burial of carcasses may impact the quality of surface and ground water resources. Several contaminants of concern are present in carcasses that may leach into the surrounding soil and migrate to surface and ground water. These contaminants were first discussed in chapter 3 (i.e., antibiotics; ash; chloride; dioxins, polycyclic aromatic hydrocarbons, and other combustion byproducts; hormones, metals; micro-organisms including pathogens; nitrogen-containing compounds, such as ammonia and nitrate; oils and grease; pharmaceutical drugs with various veterinary uses such as euthanasia; phosphorous; sulfates; total dissolved solids; and, total organic carbon). These contaminants have been detected in leachate from the disposal of swine, cattle, and poultry carcasses (Engel et al., 2004; Pratt and Fonstad, 2009). The presence of antibiotics, pathogenic micro-organisms, and veterinarian pharmaceuticals reflect the specific industry.

Leachate from carcass burial has been shown to impact water quality parameters, such as pH, conductivity, and biological oxygen demand (Yuan et al., 2013; Glanville et al., 2006). Many of these pollutants and water quality parameters are listed as reasons for water impairment under section 303(d) of the CWA. Excessive nutrient loading from phosphorus and nitrogen compounds, as well as total dissolved solids and pathogens, are common causes of impairment in U.S. waters. Unlined burial in sensitive areas may contribute to additional contaminants in impacted waters, or result in impairment of otherwise healthy water bodies. The potential for impacts to water quality may be greater for carcasses that contain biological, chemical, and/or radiological agents in high concentrations, as some of these agents could also leach through soils and impact water quality.

In addition to leachate, the heavy equipment used when burying carcasses can disturb soil and cause sediment runoff to surface water. In cases where plants are not able to revegetate an area after disposal, further sediment transport to surface water from wind and rain erosion is possible.

The potential for the contamination of surface or ground water from unlined burial activities is reduced when disposal activities meet guidelines regarding the proper burial of carcasses. The application of buffer zones from surface water, limitations on burial activities in proximity to the ground water table, and consideration of soil types can be effective means of reducing the potential contamination of surface and ground water resources. Guidelines vary widely from State to State and, therefore, there is uncertainty regarding the effectiveness of different recommendations (Freedman and Fleming, 2003). Unlike rules and regulations, State guidelines and recommendations (see table 4–1 for examples) are not mandatory, and their use may not be assured. Consequently, the safety of unlined burial is difficult to ensure.

b. Open-Air Burning

Open-air burning may contribute to water contaminants. Combustion byproducts, such as ash and air emissions, can be directly deposited onto surface water and, in some cases, may become deposited into ground water when bound to soil and transported via leachate. Ash management practices can dictate whether it will impact water quality. If ash is exposed to precipitation, contaminants can leach from the ash into the soil and surrounding ground water. Ash left onsite, or transported offsite for land application to fields to enhance plant growth, may pose a threat to water quality. Excessive ash, and its associated components, may be transported to adjacent surface water. Federal and State guidelines provide recommendations regarding the maximum amount of ash that may be applied to fields, given site-specific conditions, to reduce the potential for negative impacts to water quality.

Additional potential impacts would be expected from carcasses that contain chemical or radiological agents. Burning carcasses that contain contaminating agents, even if allowed under Federal, State, and local regulations, could create an ash that is contaminated. The destruction of organic chemicals would be related to the combustion efficiency of the burn, which is more difficult to regulate during open-air burning as compared to incineration at a facility. If the open-air burning follows proper protocol, most organic chemicals would be degraded during combustion activities; however, the impacts of their byproducts would need to be considered. Metals would be less likely to be destroyed during combustion, and would be present in the ash. Radiological agents would not be destroyed and would be present in ash. The bioavailability of metals and radiological materials would vary depending on site-specific conditions and the type of pollutant. In some cases, these materials would bind to ash, reducing availability, and subsequently partition into sediments in aquatic environments. The onsite open-air burning of carcasses may be restricted by Federal or State rules or regulations.

Table 4–1. Examples of Recommendations for Protecting Water Sources During Carcass Burial.

Federal or State Agency	Best Management Practices (BMPs)
National Resource Conservation Service (NRCS, 2003b)	at least 150 ft down gradient from any water supply source at least 100 ft from a water body or stream no closer than 2 ft from bedrock or the seasonal high water table located in suitable soils such as those suitable for a sanitary landfill (trench)
Alabama (NRCS, 2009)	at least 300 ft up gradient or 150 ft down gradient from any well at least 100 ft from a water body, stream, or drainageway no closer than 2 ft to bedrock or the seasonal high water table in soils with a permeability of less than 2.0 in/hr (soils with greater permeability will be avoided or will have a liner installed)
Minnesota	cover with 3 ft of dirt and stay five feet above the water table avoid sandy or gravelly areas, or areas within 10 ft of bedrock not in or near lakes, ponds, rivers, streams, wetlands, ditches or wells do not bury in areas with a high seasonal water table do not bury in "karst" or sandy areas do not bury in areas subject to surface water flooding
Nebraska (NDEQ, 2013)	5 ft of separation from the bottom of the burial pit to ground water 4 ft of compacted cover soil 1,000 ft from public water supply wells, 500 ft from domestic wells and outside of any well-head protection areas 300 ft from domestic water intakes, streams, creeks, ponds, springs and lakes and at least 100 ft from the edge of a major cut or embankment
Texas (TCEQ, 2005)	at least 300 ft from the nearest drinking water well, creek, stream, pond, lake, or river, and not in a floodplain at least 200 ft from adjacent property lines

2. Standard Procedures Alternative

Rendering, incineration, and landfill alternatives are conducted at offsite, preexisting locations and are expected to result in less impacts to water than unlined burial or open-air burning. The release of chemicals directly into water or into the air, subsequently landing or moving into water from these facilities, are regulated through a Federal or State permitting process. In addition, the controlled environments of these facilities are more effective in processing carcasses and containing associated pollutants, compared to unlined burial and open-air burning. Because these facilities already exist, the need for soil disturbance is reduced compared to onsite disposal options that can result in erosion and transportation of sediments and other contaminants to surface and ground water. When composting is conducted properly, less impacts than the no action alternative are expected.

a. Rendering

Rendering plants typically generate large quantities of wastewater during operation. Wastewater can contain elevated levels of nitrogen, phosphorus, ammonia, oil and grease, salts (chloride and sulfate), and other organic matter that are measured as total dissolved solids (Sindt, 2006). The discharge of this wastewater is regulated under the CWA through the NPDES, which may be administered at the Federal level or delegated to the States. Maximum effluent discharge amounts are established for each facility, and are based on criteria for the protection of aquatic life and human health.

As discussed in the previous soil and air quality sections, VOCs may be released into the air and then migrate into nearby water sources. Use of rendering should not be used if radiological agents and certain chemicals or biological agents are a concern.

b. Fixed-Facility Incineration

Incineration facilities significantly reduce the potential for aerial deposition of pollutants to enter surface and ground water sources compared to onsite open-air burning (Pollard et al., 2008). Similar to open-air burning, the proper disposal of ash would minimize the potential for runoff and leachate to surface and ground water. Federal and State recommendations are available regarding the use of incinerators and disposal of ash to fields or to trash disposal systems (NRCS, 2009). Aerial deposition of contaminants into surface water (e.g., polycyclic aromatic hydrocarbons, dioxins, and other byproducts of combustion) may also occur. However, this is expected to be a minor pathway of exposure as these emissions from most incinerators are regulated under the CAA.

c. Composting

Leaching or runoff of pollutants may occur from composting carcasses; however, when compared to unlined burial, the risks appear to be lower for most contaminants (Glanville et al., 2006). Composting may reduce the occurrence of pathogenic micro-organisms, as well as enhance the degradation of some organic chemicals, such as therapeutic and euthanasia drugs that could leach from compost and impact water resources (Schwarz et al., 2013; Donaldson et al., 2013; Guan et al., 2010). The effectiveness of composting to degrade micro-organisms and organic chemicals is dependent upon proper management of the compost.

The impacts to water quality from composting may be more significant when disposing of carcasses that contain biological, chemical, and/or radiological agents. Metals would be expected to bind to organic matter present in the compost, reducing the availability for uptake by plants or other organisms. In some cases, chemicals, chemical degradation products, and pathogens can be distributed over land as a soil amendment. This may result in pollutants that could be transported via runoff or leachate into surface and ground water resources. Guidelines regarding composting are available from Federal and State agencies, as well as university extension offices (Seekins, 2011; Mukhtar et al., 2008; APHIS, 2005).

Assuming composting, including land application of composted material, is done according to site-specific soil characteristics and guidance from Federal and State agencies, the disposal option should have less impacts to water quality than the no action alternative. Material may be placed on an impermeable or semipermiable barrier during composting and is monitored; therefore, compost leachate is less likely to contaminate surrounding water than unlined burial leachate.

Composting is also expected to have less of an impact on water quality when compared to open-air burning. Open-air burning releases pollutants related to combustion (e.g., particulate matter, smoke, etc.) and potential emissions of contaminants related to incomplete combustion. These pollutants may land on or migrate to nearby sources of water. Composting would not result in the release of pollutants related to combustion. Composting can release some VOCs; however, these are expected to be minimal under proper composting management guidelines.

d. Landfill

Provided that leachate from landfills is collected and disposed of according to regulations, impacts to water quality from the disposal of carcasses in landfills is unlikely.

E. Vegetation

1. No Action Alternative

Under the no action alternative, the potential for impacts to vegetation are greater than the potential for impacts under the standard procedures alternative. This is because the no action alternative will primarily take place on range and cropland while the standard procedures alternative will primarily take place at preexisting offsite facilities.

a. Unlined Burial

In general, the removal of vegetation could cause short-term losses in grazing or crop operations, as well as impacts to the microclimate in the immediate vicinity of a burial site. The canopies of plants modify the microclimate beneath and around them by intercepting precipitation and shading the ground, which influences the amount of soil moisture available to plants (Breshears et al.,1998). The removal of vegetation is likely to result in higher soil temperatures which, in turn, decrease the amount of surface soil moisture available to plants. These changes to the microhabitat are likely to indirectly impact invertebrate, reptile, and mammal species; however, the impact to most species is expected to be short term and limited in area as vegetation will regrow over time.

Although the process of decomposition is largely controlled by soil conditions, soils located near human burial sites tend to contain elevated levels of organic carbon and plant-available phosphorus, which can aid plant growth (Carter et al., 2007). The same impacts may occur at livestock burial sites, if conditions are right. Certain soil types are conducive to greater capillary action, and water and nutrients could move upward against gravity. If this situation occurs, it may be considered a beneficial impact of this disposal option. Lastly, compaction of soils from burial equipment may increase soil-bulk density values, which may result in decreased revegetation rates.

b. Open-Air Burning

Potential impacts to vegetation from open-air burning are expected to be equal to or greater than those described for unlined burial. If the carcasses are placed above or within a shallow pit (dug to aid the burning process), it may be necessary to remove vegetation, similar to the process described for the unlined burial method. There is a risk of fire spreading outside of the controlled pyres. This risk increases when carcasses are burned in windy areas and near dry vegetation. Open-air burning also requires an area to pile extra wood for fuel so additional vegetation may be crushed.

The ash created as a byproduct of carcass burning has been shown to be a valuable source of slow-release nutrients beneficial to plants (Sharrock et al., 2009). Ash that is collected and subsequently applied to cropland or rangeland as a fertilizer can be considered a beneficial impact of this disposal option by encouraging improved growth of vegetation. Lastly, compaction of soils from large equipment used during burning may increase soil-bulk density values, which may result in decreased revegetation rates.

2. Standard Procedures Alternative

Offsite rendering, landfill, and fixed-facility incineration would not impact vegetation as the facilities are preexisting; therefore, digging or disturbance to vegetation is not required. Composting will temporarily bury or crush vegetation.

Depending on whether the carcass compost pile is placed directly on the ground, an impermeable barrier is placed underneath the compost pile, or a biodegradable carbon source is placed on the ground, seepage of organic material onto the soil may occur. At low levels and concentration, exposure of vegetation may benefit plant growth, while concentrated surges may prove fatal. Federal and State guidelines provide recommendations regarding the application of compost to fields that will minimize the potential for negative impacts to vegetation (NRCS, 2003a).

3. Impacts Common to All Alternatives

Carcasses may need to be temporarily stored in piles prior to disposal. The temporary piling of carcasses can sometimes take place in a vegetated area, regardless of the alternative chosen. This action will bury, crush, and even kill the vegetation beneath the carcasses. Also, large machinery being moved repeatedly across a premise can have a similar effect.

4. Executive Order 13112, National Invasive Plant Species

EO 13112 established the National Invasive Plant Species Council that calls on agencies to work in order to prevent and control the introduction and spread of invasive species. The carcass management options of rendering, landfill, and fixed-facility incineration are not expected to increase risks of invasive plant species because no digging or disturbance to vegetation is required. The carcass disposal options of unlined burial, open-air burning, and composting are all likely to disturb vegetation to varying degrees. This may cause nonnative, invasive plant species to invade the burial, burning, and composting sites, resulting in degraded ecosystem productivity and reduced biodiversity (Mullin et al., 2000). This may have negative impacts on native plant and animal communities (Hoyt, 2006), although APHIS believes these impacts to be minimal.

F. Humans

1. Health and Safety

Carcasses from a mass animal health emergency and carcass management during a mass animal health emergency can pose adverse health risks to humans. Adverse health risks are due to potential exposure to zoonotic, physical, chemical, and radiological hazards. Emergency responders will generally have a higher risk of exposure to these potential hazards than members of the general public. The human populations likely to be affected during a mass animal health emergency include emergency response workers handling and managing the carcasses; the farming community (primarily livestock producers and their families); and the general public living near or transiting through an affected area. Nearby residents in a farming community are more likely to be impacted by a mass animal health emergency than individuals transiting through the area.

Similarly, members of a nearby resident farming community are more likely to experience impacts from a mass animal health emergency than individuals experiencing properly contained carcasses transiting through their community.

In the following sections, prions are provided as examples of biological agents that may be present in carcasses, and are a concern during carcass management. This EIS discusses prions as a worst-case scenario due to the difficulty in inactivating the agent.

a. No Action Alternative

(i) Unlined Burial

By implementing a comprehensive health and safety plan, which includes the proper use of personal protective equipment, potential exposure of workers to zoonotic pathogens and other hazards associated with burial is minimized. BMPs for carcass burial have also been developed to reduce the likelihood of exposure to the public. Public health impacts associated with unlined burial arise from exposure to pathogens and chemicals released into the environment during decomposition. *E. coli*, *Campylobacter* spp., *Salmonella* spp., *Leptospira* spp., *Cryptosporidium* spp., *Giardia* spp., and/or prions can all move from leachate produced after unlined burial.

Proper site selection and burial procedures can mitigate the spread of diseases and eliminate human exposure to zoonotic pathogens, despite pathogen persistence in an anaerobic environment (Nutsch and Spire, 2004). Burial sites located on a shallow ground water table, sandy or gravelly soil, or close to a waterway, residence, or drinking water sources present risks of ground water contamination, and generally are precluded by State regulations or rules. Because buried pathogens may inadvertently enter the animal feed, the human food production chain (The European Parliament, 2002) and drinking water sources, disposal methods under the no action alternative are not acceptable options when carcasses contain certain pathogens.

In addition, unlined burial releases high concentrations of ammonia, organic acids, and gases (e.g., carbon dioxide or methane) (Nutsch and Spire, 2004) which may be toxic to humans. Methane is highly explosive at concentrations of 5 to 15 percent in air (Zabetakis, 1965), and can migrate to subsurface structures, (e.g., basements) causing an explosion hazard. High concentrations of methane may displace oxygen supply and cause hypoxia, resulting in headache, dizziness, weakness, nausea, vomiting, loss of coordination, and suffocation, especially in confined spaces (HSDB, 2014; U.S. National Library of Medicine, 2014). Manure, which could be present at disposal sites, releases nitrous oxide. Adverse effects of nitrous oxide are reported after long-term occupational exposures (Brodsky and Cohen, 1986); however, APHIS does not anticipate any impacts from this gas during carcass management.

(ii) Open-Air Burning

Air emissions from open-air burning pose direct inhalation risks to both workers and the nearby general public from the released smoke. Pollutants are released into the air and become dispersed and diluted in the atmosphere, generally creating fewer impacts as the distance from the source increases. Ideally, complete combustion produces carbon dioxide and water vapor; however, open-air combustion reactions are usually incomplete, and may also release active pathogens, carbon monoxide, hydrogen, nitrogen, and sulfur oxides into the air. All of these byproducts can adversely impact human health if sufficient doses are inhaled.

Particulate matter within the smoke released from the open-air burning of carcasses can cause lung damage. Particulates can also carry toxic organic chemicals (e.g., polycyclic aromatic hydrocarbons (PAHs)) that can adversely affect the respiratory tract. Incomplete carcass combustion can produce dioxins, which are carcinogens that can adversely affect human reproduction, development, and immune systems (Gwyther et al., 2011). Petroleum products (e.g., diesel) may be used as accelerants to achieve temperatures high enough to adequately burn carcasses. When this is done, hydrocarbon residual compounds may contaminate soil and ground water (NABCC, 2004a), and the use of petroleum accelerants can be a fire and/or explosion hazard (Extension, 2013). Hydrocarbon contaminated ground water can cause both acute and long-term health effects in humans if consumed, depending on the type and concentration of hydrocarbons.

Open-air burning releases uncontrolled heat into the environment. Exposed workers may become burned or suffer heat exhaustion and heat stroke (Extension, 2013). During windy conditions, uncontrolled heat emissions from open-air burning can pose a risk of spreading fires.

There are other potential human health impacts from open-air burning that relate to the ability of open-air burning to kill or inactivate biological agents present in the carcasses. In general, open-air burning can destroy most zoonotic pathogens, including viruses and non-spore-forming bacteria (Kastner and Phebus, 2004). This means open-air burning is a viable option when pathogens cannot survive or be disseminated by this method. Prions are able to survive if there is incomplete combustion, therefore, another disposal procedure should be used when carcasses are contaminated or potentially contaminated with prions. Open-air burning is less likely to be successful as a control for pathogens that can be disseminated via airborne pathways, such as anthrax. Nevertheless, the 2004/2005 outbreak of anthrax in Uganda successfully used open-air burning against the pathogen (Wafula et al., 2008) despite debate over the role of open-air burning in contributing to pathogen spread (Kastner and Phebus, 2004).

Human psychological effects of open-air burning include the visual impact of piles of carcasses on fire (NABCC, 2004b). Open-air burning also emits odors. Carcass pyres during the 2001 FMD outbreak in the United Kingdom resulted in smoke plumes that caused despair for the nearby farming community, and reduced tourism in the affected areas. In addition, a belief that odors from carcasses carry pathogens may cause members of the general public unwarranted anxiety.

b. Standard Procedures Alternative

(i) Rendering

The rendering process presents four distinct situations associated with human health risks. The first situation may occur when animals affected by diseases caused by prions are rendered because the conditions normally used during rendering cannot completely inactivate prions (Gwyther et al., 2011). Second, the potential presence of euthanasia compounds in rendering byproducts needs consideration. The next situation arises when there is improper treatment of wastewater products. The last situation occurs when an unavoidable but regulated product, namely unacceptable odors, are released into the environment.

Carcass rendering generally uses pressurized steam at 239 to 309 °F for 40 to 90 minutes in continuous- or batch-flow units to inactivate bacteria, viruses, protozoa, and parasites (Meeker, 2006). These conditions cannot guarantee complete inactivation of prions; however, health risks to the general public are low when the facility meets all regulations, industry standards, and uses proper handling and storage procedures.

Because the use of ruminant tissue in ruminant feed was probably the contributing factor responsible for the BSE outbreak in the United Kingdom, and because of the current evidence for possible transmission of BSE to humans, FDA instituted a ruminant feed ban in 1997 followed by regulations in 2009 establishing an enhanced BSE-related feed ban in the United States (21 CFR 589). The regulations prohibit most proteins, including potentially BSE-infectious tissues known as “specified risk materials” (SRMs) from all animal feeds, pet foods, and fertilizers, not just from cattle feed as required by the ban instituted in 1997. Removing SRMs from the entire animal feed system addresses risks associated with the potential contamination of cattle feed during production, distribution, storage, and use. Applying the same measure to pet food and fertilizer materials addresses the possible exposure of cattle and other susceptible animals to these products, thereby virtually eliminating the potential indirect prion disease risk to humans from rendered products. Additionally, when animals are euthanized, their carcasses should not be used as feed for other species because euthanasia compounds remain in the tissues, and may not be broken down during rendering processes. In these situations, rendering is either avoided or the rendered output is subsequently incinerated (Auvermann et al., 2004).

Wastewater byproducts of the rendering process can pollute surface water, ground water, and soil resources if they are not adequately contained or properly handled. Wastewater from rendering facilities is regulated to preclude movement of toxic compounds into natural resources, and eliminate contamination of the water supply.

Odoriferous byproducts from rendering can pollute the air if inadequately contained or improperly handled. Odor from the anaerobic breakdown of proteins by bacteria during rendering is minimized by various technologies, such as treating emitted odors in condensing units, followed by effective and reliable operation of scrubbers and afterburners, biofilters for noncondensable odors, and air quality monitoring. These various odor-controlling techniques reduce the likelihood that people will detect the odors. Further, odor-control techniques minimize the facility's attractiveness to insects and pests vectoring diseases (Auvermann et al., 2004). Reductions in these nuisances can positively impact human health.

(ii) Fixed-Facility Incineration

The human health risks for incineration are associated with air emission and ash disposal. Similar to open-air burning, pollutants, such as particulate matter, PAHs, dioxins, and other chemicals released via air emission during the incineration of carcasses can cause adverse effects to human health. However, incineration of carcasses at a fixed-facility incinerator is a highly controlled process designed to minimize human health risks from air emissions. Incinerator air emissions are regulated through a permitting process, therefore, there are fewer compounds released than from an open-air burning situation; this greatly reduces the likelihood of adverse health effects from air-borne pollutants released during the incineration process.

Ash produced from incineration is typically considered safe and cause minimal health effects. Fixed-facility incinerators can effectively destroy zoonotic pathogens, including prions (e.g., TSE) in animal carcasses. However, if the level of TSE remaining in incineration ash is a concern, ash may be disposed at a landfill.

(iii) Composting

The human health risks for composting include the potential for (1) disease transmission from pathogens remaining in the composted material, (2) leachate contamination of ground water and soil, (3) the vectoring of diseases from vermin attracted to the compost piles, and (4) odors. Each topic is discussed by recognizing the separate risks to workers and the general public.

Proper carcass composting techniques result in compost piles reaching a temperature of 160 to 180 °F for several days, which inactivates many pathogens (including viruses, protozoa, helminths (worms classified as parasites), and many bacterial species) in the compost. However, the temperatures and conditions reached during composting do not eliminate prions and spore-forming bacteria (such as *Bacillus anthracis*, the causal agent of anthrax, and *Mycobacterium tuberculosis* which causes tuberculosis) (Berge et al., 2009, Mukhtar et al., 2004). When compost generated from carcasses that were contaminated with prions or spore-forming bacteria is spread on agricultural land, these pathogens may be transmitted to workers. Wearing proper protective equipment, such as respirators, can minimize the potential for worker exposure to aerosolized pathogens.

The general public is not likely to become infected with prions or these bacterial pathogens unless they consume raw, unwashed produce contaminated with the compost. While proper harvesting and storage conditions, along with adherence to hazard analysis and critical control point procedures (an approach used by USDA to prevent hazards in production processes) minimizes the likelihood of consumption, the potential for impacts to human health can be avoided by not composting carcasses infested with prions and/or spore-forming bacteria.

Composting sites can impact human health when contaminated water and leachate (containing various organic compounds) migrate into surface or ground water. A properly selected composting site seeks to minimize potential human health impacts, in part, by reducing surface water runoff, movement of leachate, and migration of composted nutrients into ground water (Berge et al., 2009; Mukhtar et al., 2004). A properly constructed compost pile would include a sufficiently thick base layer of carbonaceous material, such as wood chips or an impervious liner to minimize migration of leachate from the compost to the soil and ground water.

Improperly constructed compost piles can produce odors that attract flies, vermin, and scavengers. These pests may carry or transmit pathogens from the composting areas to humans. An adequately thick cover layer of wood chips or other carbon source will mitigate this risk.

The carcass composting process produces gases such as carbon dioxide, ammonia, hydrogen sulfide, and odors associated with the liquid or solid biomass (http://fss.k-state.edu/FeaturedContent/CarcassDisposal/PDF%20Files/CH%203%20-%20Composting.pdf). Proper composting techniques (e.g., adequate cover material) (Rahman et al., 2009, Hao et al., 2009; Xu et al., 2007) reduce the release of these gases.

(iv) Landfill

Landfills require long-term management of waste because the time required for degradation depends on the specific conditions within the landfill. With proper design and long-term management, the human health risks from landfill disposal of animal carcasses are considered to be minimal. Waste disposal in a regulated landfill poses little risk to human health if the proper mitigations are followed. Mitigations include liners at the bottom of the landfill, cover materials (such as soil and vegetation) at the top of the landfill, and gas control systems (which collects and removes gases). These mitigations reduce the likelihood of uncontrolled leachate and/or gases moving into the environment and potentially affecting the human water supply. Appropriately engineered landfill site can contain prion-infected carcasses and pose little risk to human health (Nutsch and Spire, 2004).

There may be human psychological impacts from landfilling large numbers of carcasses, but these impacts can be minimized through public outreach and education. Public concerns sometimes focus around the potential for landfills to experience technical failure (Giusti, 2009). Further, there may be public concerns about increased traffic or the transportation of carcasses through neighborhoods in route to a landfill. For these reasons, outreach and education could minimize concerns and minimize psychological impacts before landfill disposal is used during a specific mass animal health emergency, especially when infectious disease control is an issue.

c. Impacts Common to All Alternatives

(i) Zoonoses

During a mass animal health emergency, workers can become exposed to zoonotic pathogens and become ill. Exposure to zoonoses can occur through direct contact with carcasses or indirectly by contacting a contaminated source during the various stages involved in carcass management. These stages include carcass handling, transportation, processing, storage, disposal, and cleanup. Preventing the spread of diseases requires timely selection of a proper disposal method, establishing biosecurity procedures to control access and minimize the amount of traffic on and off the premise, and ensuring proper disinfection methods are used.

Prior to any carcass management work, workers should be fully briefed on the nature of the disease and trained in specific hygiene requirements. Diseases can be either zoonotic or non-zoonotic. For non-zoonotic diseases, biosecurity practices generally are minimal unless the disease is highly transmissible to other animal populations. Conversely, risks to human populations trigger stringent biosecurity practices.

To protect worker health and safety, and prevent the spread of harmful agents beyond the controlled area, APHIS developed a standard operating procedure (SOP) for the disposal of carcasses (APHIS, 2012a). This disposal SOP discusses the establishment of safe working practices, outlines how to identify required personal protective equipment, and describes safety training requirements. The proper use of personal protective equipment is essential for worker protection and disease control as it provides the first line of defense, and is under the direct control of each individual worker. (For more information in the selection, types, and proper use of personal protective equipment, see the FAD PReP/NAHEMS Guidelines: Personal Protective Equipment (PPE) (2011), FAD PReP/NAHEMS Guidelines: Biosecurity (2011), and APHIS' Web site with SOPs at http://inside.aphis.usda.gov/vs/em/fadprep.shtml.)

In addition, the Occupational Safety & Health Administration Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard applies to any employee that is exposed or potentially exposed to hazardous substances, including hazardous waste. The standards apply to those individuals that are involved in cleanup operations or operations involving hazardous wastes (as defined in 40 CFR 261.3 or 49 CFR 171.8) at treatment, storage, and disposal facilities (actions regulated by 40 CFR Parts 264 and 265 pursuant to RCRA) (OSHA, n.d.)

The level of risk posed by a zoonotic agent to the general public depends on specific pathogen transmission characteristics. The potential exposure of the general public to harmful zoonotic agents through direct contact is unlikely if carcasses are properly handled and the site is secured. Pathogens, however, may move from the emergency site through other pathways, such as wind and ground water (Drayer and Russell, 2004). Pathogens may also be transported by visiting animals (birds, mammals, and insects) or on equipment as it is moved (Drayer and Russell, 2004). Scavengers such as rodents, necrophagous birds (birds that feed on carcasses), and stray dogs that use carcasses and animal waste as a food source may spread the remains of carcasses over a large area, increasing the risk of pathogen spread (FAO, 2005). Barriers will help prevent animals from entering and exiting the site and transporting pathogens offsite.

Pathogens can inadvertently be carried offsite by workers, visitors, or intruders. Site security systems can prevent unauthorized personnel from accessing the area and spreading diseases. Decontamination of personnel prevents cross-contamination, and minimizes the risk of transporting disease agents (Baird and Savell, 2004). For offsite disposal methods, a decontamination station located near the exit of the carcass management site allows thorough cleaning and disinfection of all personnel, vehicles, equipment and material prior to leaving the site. These practices minimize potential health effects to offsite workers and the general public.

(ii) Chemical and Radiological Agents

Humans may be exposed to chemical and radiological agents through direct or indirect contact. Agents migrate through the air, soil, surface water and/or ground water, and may be ingested, inhaled, or enter the human body via dermal routes.

Chemical and radiological agents of concern are discussed in chapter 3.B.4. If there is a mass animal health incident where chemical or radiological risks are present, a site-specific EA should analyze the scenario, and allow decisionmakers flexibility regarding how to minimize exposure to workers and the public from carcass management. While adverse health effects can include death, if the chemical or radiological exposure is sufficient, exposure can be mitigated using the proper techniques and personal protective equipment, as discussed in the previous section (chapter 4.F.1.c.i.).

Humans exposed to chemicals are treated by clinical syndrome categories rather than by the specific agent; treatment modalities include burns and trauma, cardiorespiratory failure, neurologic damage, and shock (CDC, 2000). Sublethal health effects from exposure to chemical agents range from minor irritation to organ system failure, depending on the type of chemical and the amount of exposure. For example, health effects from direct contact to arsenic include skin lesions, peripheral neuropathy, gastrointestinal symptoms, diabetes, renal system effects, cardiovascular diseases, and cancer. Benzene can cause cancer and aplastic anemia. Pesticides may have acute and/or chronic toxic effects, and can pose particular risks to children. Dioxins and dioxin-like substances can have immunotoxicity, developmental and neurodevelopmental effects, and changes in thyroid and steroid hormones and reproductive function (WHO, 2010). Carbon monoxide generated from gasoline-powered equipment can interfere with the delivery of oxygen throughout the body. Particulates released in completely burned fuels can irritate or damage lung tissue (MIAQC, 2010). Workers coming into direct contact with the carcass experience the most potential for exposure. Health effects and toxicological information for additional chemical hazards can be found at Toxnet (see Web site at http://toxnet.nlm.nih.gov/). In general, adherence to existing regulations and rules regarding worker protection reduces the likelihood of exposure to a negligible level.

Various types of radiation exposure (external irradiation, external contamination with radioactive materials, and internal contamination through inhalation, ingestion, or transdermal absorption) can occur in combination and be associated with thermal burns and traumatic injuries. The severity of symptoms from radiation sickness varies with the received dose and over time. Factors used to determine the extent of the health effects from radiation exposure include the (a) toxicity of the radioisotope, (b) type or activity level of the radiation (e.g., alpha, beta, or gamma), (c) amount of radioactivity, (d) length of exposure, (e) half-life and biological half-life of the isotope; and (f) route of acute exposure (e.g., inhalation, ingestion, and external radiation) (Karam, 2005; EPA, 2012). For the safe management of radioactive carcasses, Federal (e.g., NRCS, the Department of Energy, and the Department of Transportation), State, and other organizations' waste management regulations implement applicable radiation protection standards developed by the EPA (EPA, 2012) and the U.S. Department of Labor's Occupational Safety and Health Administration.

Workers should take precautions handling animal carcasses if they are contaminated with radiological materials (Bushberg et al., 2007), even though exposure to low levels of radiation pose little or no risk to their caretakers (NATO, 2004). Individual biodosimetry (a detector used to measure the dose of radiation received by an individual) is used to predict the clinical severity, treatment, and survivability of exposed individuals and triage those individuals minimally exposed (Waselenko et al., 2004; Williams et al., 2010). The radiation dose limit for emergency workers should not exceed recognized occupational dose limits of 25 rem (unit of effective absorbed dose of ionizing radiation in human tissues) (DOE, 2001), depending on the circumstances (Olkin, 2006; Wrixon, 2008; 10 CFR part 20.1201). To protect public health, EPA limits public exposure from specific sources to levels below 100 millirem (mrem) (EPA, 2012).

(iii) Potential Environmental Hazards

Exposure to environmental hazards, or secondary hazards, occurs to humans through water, air, and soil contamination. Improper carcass management leading to contamination of water supplies could present a health risk when the water is used for drinking, bathing, or cleaning. Cases of illness from the use of contaminated resources are discussed in various reports (CDC, 2013; Gwyther, et al. 2011; Pollard, et al., 2008; Joung et al., 2013). Carcass fluids and decomposition byproducts may leach into and pollute ground water. If the disposal methods are not effective to eliminate pathogens, then they may be disseminated through surface water (creeks, ponds, lakes, or rivers), ground water, and in runoff. Potentially harmful gases may be emitted into the atmosphere by decomposing carcasses; improperly managed carcasses may provide a breeding habitat for flies and other insects. Carcasses exposed on the surface of the soil may attract scavengers and rodents which carry diseases to humans. In addition to environmental hazards posed to the general public, workers may become exposed to noise, heat, cold, and petroleum byproducts used for fuel and lubrication of heavy machinery.

(iv) Potential Psychological Hazards

Psychological hazards arise from the emotional reaction evoked by massive volumes of carcasses. The sights and odors from a large amount of carcasses can be emotionally upsetting to humans because human sympathies and compassion are invoked. Losing and disposing of animals can be both psychologically and financially devastating to farm operators and their families. Mental health counseling can help to mitigate psychological health impacts.

In every mass animal health emergency situation, carcasses are likely to be collected and piled prior to disposal. The smell of decaying animal flesh causes revulsion in most humans. The general public is likely to avoid the smells by leaving the area and closing vehicle windows. People residing downwind from carcass management operations are likely to be affected because they cannot avoid the odors; however, the dilution caused by air movement over time is likely to reduce the intensity of the impact. Acute distress is likely to be felt by workers when initially confronted with odors until their olfactory system becomes desensitized during continuous exposure.

Decisionmakers must cope with these impacts in a transparent and forthright manner to ease tension in a community. Situations may be improved by simply selecting a more remote disposal site. In addition, local discussions and education are likely to be needed so public concerns can be addressed.

2. Executive Orders 12898 and 13045: Environmental Justice and Protection of Children

Federal agencies identify and address disproportionately high and adverse human health or environmental effects of its proposed programs, policies, and activities on minority and low-income populations in the United States and its territories and possessions to meet the requirements of EO 12898. EO 13045 encourages similar considerations for children.

a. No Action Alternative

Under the no action alternative, potential effects to low-income or minority communities resulting from carcass management activities will depend on the distance of the communities to the unlined burial or open-air burning sites. Impacts to a low-income or minority community are highly unlikely if the disposal site is not close to the community. During a mass animal health emergency, the locations of the immediately surrounding communities will be evaluated to identify the presence of any low-income or minority communities. If such a community is identified in the surrounding area such that impacts are reasonably foreseeable, then APHIS will conduct appropriate outreach to the potentially impacted community, and incorporate appropriate mitigations.

Under the no action alternative, site security is essential to protect children. In general, children are more susceptible to air and water pollution because of their smaller body sizes and higher respiratory rates, so they could receive a toxic dose faster than a larger adult. Further, children's normal behaviors include playing in soil which may lead to consumption of some soil particles. Contaminants in the soil could be ingested and lead to adverse health effects. By preventing access of children to carcass management activities, any pollutants released during the operations will be diluted over a larger distance before coming into contact with a child. In addition, any environmental hazards, such as fire or heavy machinery, will not impact them provided they are kept off the site.

b. Standard Procedures Alternative

Under the standard procedures alternative, when offsite facilities are selected for disposal/treatment, the likelihood of impacts to low-income and minority communities and children is reduced. This is due to the decreased potential impacts to soil, air, and water, as discussed previously in this chapter. However, transportation to offsite disposal facilities poses other types of potential impacts.

The selected transportation routes may inadvertently impact low-income and minority communities and children through additional traffic, noise, and air pollution as the carcasses are moved to a carcass management facility. The site-selection criteria used to permit construction of carcass management facilities ensures proper zoning and highway access points are met, but it may not be possible for APHIS to select facilities far from low-income and minority communities and children. Nevertheless, if a low-income or minority community or children are identified as likely to become impacted due to proximity of a carcass management facility or a selected transportation route, then APHIS will conduct appropriate outreach to the potentially impacted community, and incorporate appropriate mitigation measures under the circumstances.

If biosecurity is maintained during transportation (through confined carcasses, intact seals on trucks, etc.), then disease risks during transport are consistently low regardless of where the carcasses are moved. Incinerators emitting air pollution must meet their permit's requirements to protect the health of nearby communities. Incineration of large quantities of carcasses is not likely to lead facility operators to seek a variance from these requirements; however, it is more likely that the volume of carcasses would be restricted and additional emissions would not be produced. If a low-income or minority community or populations of children are identified in a site-specific EA such that impacts are reasonably foreseeable, then APHIS will conduct appropriate outreach to the potentially impacted community, and incorporate appropriate mitigation measures under the circumstances.

3. Cultural and Historical Resources

Federal actions must seek to avoid, minimize, and mitigate potential negative impacts to cultural and historic resources as part of compliance with the National Historic Preservation Act (NHPA; 16 U.S.C. § 470), the Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470aa-mm), and NEPA (42 U.S.C. §§ 4321-4347).

a. No Action Alternative

Impacts to cultural and historical resources could occur if unlined burial or open-air burning sites are located on premises, such as historic ranches or rangelands which are listed on the National Register of Historic Places. If burial or burning takes place on historic property, APHIS would consult with the appropriate landowners and the State Historic Preservation Office to select a site that would minimally impact cultural and historical resources. APHIS does not usually have the authority to dispose of carcasses on tribal lands, unless requested to do so by the tribe. If the proposed location for carcass burning or burial includes tribal lands, APHIS will provide carcass management expertise at the national level while allowing flexibility to manage operational activities from a tribal perspective. Activities would only take place on tribal lands in collaboration with the affected tribes.

b. Standard Procedures Alternative

An action to render, incinerate, or place carcasses in a landfill should not have an impact on cultural and historic resources as the carcasses would be shipped to a preexisting facility. Composting has the potential to temporarily impact cultural and historic resources; however, impacts are expected to be minimal as long as carcass management sites are chosen with caution.

4. Executive Order 13175: Indian Tribal Consultation and Coordination

The Archeological Resources Protection Act requires agencies to identify archaeological sites on public and Indian-held lands where a proposed action may take place, and it provides permit requirements for the excavation of archaeological resources. If there is an incident when burial is likely on public or Indian-held lands, APHIS will contact the State Historic Preservation Officer or Tribal Historic Preservation officer for more information. Additionally, APHIS will meet requirements in the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA, 25 USC §§ 3001 et seq.) with respect to Native American artifacts by consulting with Indian tribes or Native Hawaiian organizations prior to the intentional excavation or removal after inadvertent discovery of cultural items located on Federal lands. APHIS will use the National Native American Graves Protection and Repatriation Act Online Database (available at: http://www.nps.gov/nagpra/ONLINEDB/index.htm) to identify tribes and tribal lands in areas where carcass management will be conducted, and APHIS intends to consult with tribes if unlined burial is proposed on tribal lands.

Standard procedures alternatives are not likely to affect sacred sites, and are unlikely to affect the physical integrity of Native American sites (as defined in EO 13007 of May 24, 1996, “Indian Sacred Sites”) or artifacts (as recognized by NAGPRA). If any ground disturbance uncovers any item of potential cultural significance, APHIS would follow the applicable NAGPRA provisions. It is possible, however, that carcass management activities could take place near a sacred site. If management activities need to take place near a sacred site, then APHIS would contact the Tribal Historic Preservation officer for discussion on how best to proceed.

The Food, Conservation, and Energy Act of 2008 authorizes USDA to use National Forest System land for the reburial of human remains and cultural items (including those items repatriated under NAGPRA). The act also assists in preventing unauthorized disclosure of information regarding human remains or cultural items reburied on National Forest System land. Recovery and reburial would only occur in consultation with the affected Indian tribe or lineal descendant. This action would take place at Federal expense or using other available funds.

APHIS recognizes the rights of sovereign tribal nations and is committed to respecting tribal heritage and cultural values when planning and initiating programs, as defined in EO 13175 of November 6, 2000, *Consultation and Coordination with Indian Tribal Governments*. APHIS mailed all federally recognized tribes a letter in June, 2013, discussing the development of this Carcass Management EIS, requesting their comments, and providing the opportunity for consultation. Approximately 15 identified entities participated in a tribal consultation call for carcass management on June 24, 2013. APHIS provided additional detail about the different carcass management options available, explained the need for an EIS, and requested the tribes' input on carcass management techniques and strategies for carcass disposal. Tribal concerns include management of horses and bison during emergency situations, and the process for where and how to bury animals. Some tribes requested advanced notice prior to the disposal of carcasses to have time to provide a blessing of the animal carcasses prior to destruction or burial. APHIS encouraged tribes to develop their own emergency response plans, and there was some interest in adding a carcass management section to the emergency response plans already in development.

Carcass management for companion animals (e.g., horses) is not within the scope of this EIS; however, the management of livestock carcasses (e.g., bison) is under the scope of this EIS. APHIS would provide carcass management expertise at the national level while allowing flexibility to manage operational activities from a tribal perspective. APHIS would not participate in the disposal of carcasses on tribal lands without direct consultation with the tribe. In general, carcass management activities would only take place on tribal lands in collaboration with the affected tribes.

5. Socioeconomic Considerations

The economic impact of carcass management activities arises from effects on the environment, land values, public opinion, and general economic factors. It is expected that decisionmakers will select the most cost-effective combination of available options that meet the occasion's specific biosecurity needs. In general, there is a great deal of uncertainty associated with estimating socioeconomic considerations due to the wide range of circumstances that could be involved in a mass animal health emergency. In addition, many aspects of the costs associated with each option are not known at the present time.

In the case of a FAD outbreak or natural disaster, total actual costs cannot be predicted because both operating and variable costs are estimated from a small number of experiences and routine disposal estimates. The available cost data provides an opportunity to compare expected fixed and variable costs per ton of carcasses; however, these comparisons should be considered with caution for a variety of reasons. First, these estimates were derived from numerous sources and, as such, direct comparisons may not be reasonable under the circumstances. Next, the available data is based on a variety of assumptions, including differing circumstances, cause of death, scale of disposal efforts, species, dates, and geographical locations. These various sources do not consistently incorporate capital, transportation, labor, or input costs into the estimates. In addition, the decision to provide indemnity for the loss of any animals due to a FAD is a socioeconomic consideration that will be made on a case-by-case basis, and depend upon the circumstances and availability of funds.

The species and numbers of the carcasses are also important factors for determining socioeconomic impacts. Certain technologies can handle only limited numbers of carcasses per batch, and these methods may not be efficiently used during a mass animal health emergency. Some disposal options may be more acceptable within the cattle industry as opposed to the poultry industry, and vice versa. Logistical issues regarding location of the carcasses and proximity to facilities and resources (e.g., fuel) become critical considerations at the site-specific level. The best solution for one situation may differ from another.

The monetary costs due to impacts on the environment will be affected by changes in rural economy and agricultural policy regarding livestock death and carcass disposal. Outbreaks often leave limited time to select burial or burning locations, require rapid authorization of disposal permits, and can create public controversy, all of which can affect the costs incurred. For example, introduction of a FAD will elicit a rapid attempt to control and eradicate the disease (including carcass management). Adverse economic effects are caused by the disease and the public perception of animal products, which influences the willingness of trading partners to accept products. While the short-term economic effects may be greater than the cost of the disease itself, APHIS disease control programs intend to mitigate long-term impacts from the disease becoming rampant or establishing within the country.

Even with its flaws, past examples of carcass management events could provide an indication of the types of costs that could be incurred. It must be noted that these estimates made for routine carcass disposal may not reflect the costs that would be incurred in an emergency situation because of the scale of the emergency and demand on resources.

McClaskey (2004) estimated costs per ton of carcasses managed using a range of disposal methods in 2004 (table 4–2); however, those numbers do not reflect increases in fuel costs since that time. Direct costs for burial include labor and equipment for transportation and disposal. Most cost estimates for onsite disposal pits and trench burials are based on routine mortalities; the costs for disposal during a mass animal health emergency situation is likely to differ significantly. Indirect costs for burial can include environmental costs if ground or surface waters are impacted; this will influence land values in areas where this information must be disclosed on a property deed. Estimates of indirect costs are not readily available.

Table 4–2. Disposal Costs under Different Disposal Technologies (in 2004 Dollars)

Carcass Disposal Technology	Cost Range per Ton of Material Disposed*	Cost per 50 Tons (EIS threshold)
Burial	$15–200	$750–10,000
Landfill	$10–500	$500–25,000
Open-air burning	$200–725	$10,000–36,250
Fixed-facility incineration	$35–2000	$1,750–100,000
Bin- and in-vessel composting	$6–230	$300–11,500
Windrow composting	$10–105	$500–5,250
Rendering	$40–460	$2,000–23,000

* The numbers presented above should be considered with caution because the estimates are from a variety of sources. The data are based on a variety of assumptions, including differing causes of death, scale of management efforts, species, dates, and geographical location. The sources do not consistently incorporate capital, transportation, labor, or input costs. (Source: McClaskey, 2004)

a. No Action Alternative

(i) Unlined Burial

Previous studies estimated costs for onsite burials in several cases (McClaskey, 2004).

- A 2001 study by University of Nebraska researchers estimated the cost of a trench to handle 40,000 pounds of hog carcasses to be $3,878. Adjusting for inflation would result in an estimated cost of $4,970 in 2013.

- A 1995 University of Alabama study estimated the cost of routine poultry carcass disposal to be $73.60 per ton, or $112.54 in current dollars.

- A 2001 survey by the Iowa Pork Producers Association estimated for every 100 head of swine marketed, producers spend $198 for routine mortalities, or $231 in current dollars.

(ii) Open-Air Burning

In 2004, the direct costs for open-air burning ranged from $196 to $723 per ton (McClaskey, 2004). In current dollars, these costs would be about 20 percent higher. Direct costs of onsite open-air burning include fuel such as timber, coal, pallets, or diesel and ash disposal. Indirect costs of burning include air pollution, the release of noxious gases and compounds, odors, and effects from the release of ash into the air and water. The public perception of open-air burning is unfavorable; during the FMD outbreak in 2001 in the United Kingdom, the sight of pyres contributed to a loss of tourist activity. Worker safety precautions, management expenses, and permits created additional expenses (McClaskey, 2004).

b. Standard Procedures Alternative

(i) Rendering

Historically, the rendering industry disposed of approximately half of all routine livestock mortalities, and represented the preferred method of disposal. Although renderers charge fees to collect and process mortalities, they derive most of their profit from the sale of meat and bone meal. Consolidation within the rendering industry has led to fewer plants located at greater distances from the livestock operations that traditionally relied on renderers to process mortalities. The direct cost of rendering includes construction, equipment, and labor (McClaskey, 2004). FDA regulations (21 CFR 589.000) are designed to protect livestock from the threat of BSE, but it also increased the costs of rendering and resulted in rendering service fees to animal producers (Berge et al., 2009).

For a mass carcass disposal situation, the most important factors involved in the cost analysis include collection, transportation, temporary storage fees, extra labor requirements, impact on the environment (sanitations for plant outdoor and indoor activities, odor control, and wastewater treatment), and sometimes additional facilities and equipment. These expenses make the processing costs during a mass animal health emergency much higher than the usual cost of rendering. Nevertheless, a 2001 University of Nebraska study estimated the cost for routine rendering from $132 to $456 per ton to accommodate an annual mortality of 40,000 pounds. Indirect costs of rendering include a lack of biosecurity, and the risk of disease spread during transport of the carcasses (McClaskey, 2004).

(ii) Fixed-Facility Incineration

The estimated cost of fixed-facility incineration is $98 to $2,000 per ton of waste (McClaskey, 2004). In current dollars, these costs would be about 20 percent higher. Direct costs for fixed-facility incineration are associated with construction and incineration equipment.

- A 2001 study estimated a 500-pound incinerator costs $3,000 and lasts approximately 4 years. The cost per ton ranged from about $97 to $145, $131 to $190 in current dollars.

- A 1995 Alabama case study estimated the cost to incinerate poultry carcasses at $178 per ton ($272 in current dollars). A University of Tennessee study estimated $80 per ton to incinerate poultry carcasses.

- In 2001, the Georgia Department of Agriculture reported costs of $300 per ton to incinerate poultry carcasses following a tornado, or an outsourced cost of $1,600 per ton, illustrating how quickly costs can rise in a non-routine situation (McClaskey, 2004).

(iii) Composting

Direct costs of composting include a plentiful supply of carbon sources, available land, and equipment suitable for establishing and turning compost piles. These costs are affected by the volume and weight of the carcasses to be disposed of, the frequency of mortality occurrence, labor requirements, and the useful life of facilities.

- A 2001 study by the University of Nebraska estimates construction costs for a bin composting system ranged from $7,850 to $15,200.

- A 1995 example from Alabama estimated the annual cost of a large-bin composting system for poultry to be $4,939.

- A 2002 study by Sparks Companies estimated total annual costs of composting to be $40.34 for cattle, $8.54 for hogs, and $4.88 per head for other livestock (McClaskey, 2004).

An enclosed system of composting organics using aerated synthetic tubes (Ag-Bags) are commercially available. The system consists of a plastic tube 10 ft in diameter and up to 200 ft long. These tubes are equipped with an air distribution system connected to a blower. Ag-Bags were used to compost over 100,000 birds infected with AIv depopulated from poultry houses in West Virginia. The structural equipment costs were estimated at $130,000, with additional equipment operating costs of $6–10 per ton before carbon source expense or labor expenses were considered (McClaskey, 2004).

Windrow composting is a less labor-intensive option than other means of composting. Direct costs include layers of absorptive carbon material above and below the carcasses, and coverings that manage water penetration and retention. Carcasses may be punctured or pulverized prior to establishing the windrow piles. These simpler, naturally ventilated, static pile systems decompose materials more slowly, and require minimal capital and operating costs. In dry climates, open windrows may need irrigation (Berge et al., 2009).

Indirect costs of composting include odors and the risk of surface or ground water contamination if the system is not properly managed. The value of the humus byproduct could offset part of the cost of the composting if there is no risk of spreading a disease and if a market for the humus can be developed (McClaskey, 2004).

(iv) Landfill

Direct costs for carcass disposal at landfills include transportation costs and fees charged by the landfill based on the weight or volume. Fees may vary by the type of waste. Costs may rise if landfills must handle animal carcasses differently than typical household waste. Examples of costs for a small-scale disposal in Colorado include a 2001 estimate of $160 per ton ($210 in current dollars), and a 2003 Riverside County, California estimate of $40 per ton ($51 in current dollars). During a 2002 outbreak of exotic Newcastle disease in California, landfill fees were approximately $40 per ton for poultry waste (McClaskey, 2004).

G. Livestock and Domestic Animals

APHIS' carcass management regulations and guidelines have been created with the primary goal of protecting livestock and human health. Any impacts to soil, air, and/or water can impact the health of livestock. Because livestock may use water bodies for cleaning and drinking, any water contaminants could prove harmful. Additionally, grazing in contaminated soil, inhaling noxious fumes, or consuming contaminated carcasses could also be harmful. In poorly managed carcass management scenarios, there are resulting cases of livestock illness and death from contaminated resources, such as water, air, and food (NABCC, 2004a). During carcass management, care must be taken not to store or dispose of carcasses where they can be contacted by healthy livestock or impact water and/or food supplies.

This section will also briefly discuss potential impacts to domestic animals (e.g., dogs and cats) that may be in the vicinity of carcass management sites. Domestic animals may exhibit some similar behaviors as livestock, which will put them at risk for similar impacts.

1. No Action Alternative

Because impacts to soil, air, water, and vegetation are expected to be greater under the no action alternative than the standard procedures alternative, potential impacts to livestock and domestic animals may be greater. Any contamination of the soil, air, water, or vegetation, could impact the health of livestock or domestic animals in the area. The no action alternative could result in a reduction of available grazing land while the land is used for unlined burial or open-air burning. In addition, if proper procedures are not followed, livestock grazing land could be lost due to subsequent contamination by biological, chemical, and/or radiological agents.

When carcasses contain biological, chemical, and/or radiological agents, there is an increased risk that these agents could enter the animal food chain and water supply due to their incomplete inactivation, dilution, or degradation during burial and burning. Viruses, such as FMDv, are quickly inactivated by burning. FMDv was shown to be inactivated at approximately 140 °F (60 °C) (Kamolsiripichaiporn et al., 2007); however, particular concern relates to the safe management of prions. If unlined burial and open-air burning are only used under the appropriate circumstances, and any appropriate regulations and/or guidance are followed, impacts to livestock and domestic animal health should be minimal.

2. Standard Procedures Alternative

Under the standard procedures alternative, rendering, fixed-facility incineration, and landfill would take place offsite. The livestock grazing areas would not be impacted by these management options, and potential contamination of livestock and/or domestic animals with biological, chemical, and/or radiological agents could be more effectively prevented.

Compost piles will effectively degrade micro-organisms and some organic chemicals, if properly managed. However, surrounding livestock and domestic animals must be kept away from compost piles so these animals will not attempt to consume degrading carcasses that may contain harmful agents that are not yet degraded. If not properly managed and/or if carcasses are composted that contain certain biological, chemical, or radiological agents that cannot be inactivated, diluted, or degraded by composting, the health of surrounding livestock and/or domestic animals would be at risk.

3. Impacts Common to All Alternatives

There are carcass management activities that have the potential to impact livestock and domestic animal health, regardless of the alternative chosen. Under each alternative, carcasses will usually need to be piled while awaiting disposal. Body fluids could leak into/onto the ground, water, vegetation, and feed. Nearby grazing livestock and/or domestic animals could come into contact with contaminated soil, feed, or water, or with contaminated carcasses. Therefore, regardless of the carcass management alternative used, carcasses should be kept away from the feed, water, or grazing/roaming areas of livestock and domestic animals while awaiting disposal.

4. Potential Mitigations

Various potential effects listed above can be controlled by adequate training of carcass handlers and properly piling carcasses. A suggested mitigation for temporarily piling carcasses or for burial, burning, or composting sites is to set aside or designate land for potential carcass management activities. The land could be on the property or designated on a nearby property, however, at a safe distance from surrounding livestock and domestic animals.

H. Wildlife

This section covers the impacts to wildlife health that may result from the proposed carcass management alternatives. Carcasses could contaminate surrounding water bodies, soil, air, and/or vegetation leaving wildlife susceptible to health risks. In addition, the consumption of contaminated carcasses could be harmful to the health of wildlife. The discussion below will focus primarily on the potential effects to wildlife health from biological, chemical, and/or radioactive agents that carcasses might carry.

1. Health

a. No Action Alternative

Any contamination of the soil, air, water, or vegetation could impact wildlife. Because the potential for impacts to soil, air, water, and vegetation are expected to be greater under the no action alternative than the standard procedures alternative, the potential for impacts to wildlife are also expected to be greater under this alternative.

When carcasses contain biological, chemical, and/or radiological agents, these agents could enter the animal food chain and water supply during burial and burning. For example, viruses (e.g., FMDv) are quickly inactivated by burning. FMDv was shown to be inactivated at approximately 140 °F (60 °C) (Kamolsiripichaiporn et al., 2007); however, prions and spore-forming bacteria may persist during incomplete combustion. Burning of carcasses may also produce dioxins which may be deposited on soil and water down-wind of open-air burning sites. Unlined burial produces leachate which can transport contaminants to ground water and surface water. These uncontrolled disposal methods have the potential to harm wildlife.

Carcasses contaminated with chemical and radiological agents would pose a risk to wildlife if they are buried or burned. Unlined burial has the potential to leak biological, chemical-and/or radiological agents into the water supply and soil. Animals could then become exposed to harmful agents as a result of feeding on contaminated carcasses that are not properly buried, feeding on vegetation in the vicinity of the contaminated carcasses, or consuming contaminated water. Burning livestock contaminated with chemical or radiological agents could also result in toxic fumes that could harm wildlife in the area. Air pollutants, such as dioxins from incomplete carcass combustion, are carcinogens and can cause adverse impacts to wildlife. Dioxins can cause deformities in and interfere with reproduction of wildlife, especially of fish, birds, and reptiles (Monks, 1994). The highest concentrations of dioxins can be found in higher-order predators, cormorants, and raptors (Ministry of the Environment, 2009).

Unlined burial and open-air burning also pose other hazards to wildlife. These management options risk temporary or long-term disturbance of wildlife populations and habitat. Mass burial has the potential to take valuable habitat away from wildlife species. For the seven mass burial sites following the FMD outbreak in the United Kingdom, the land area occupied ranged from 42 to 1,500 acres (NAO, 2002).

Open-air burning results in an alteration of vegetation availability and quality and could reduce cover and shelter opportunities for wildlife. Also, an ambient air temperature of approximately 145 ºF can result in animal mortality (Ministry of Agriculture, 2004). Wildlife nesting or raising young have limited mobility and are most impacted by fire. Those species that construct surface-level nests (e.g., harvest mice, woodrats, and ground-nesting birds) also are vulnerable to fire (Ministry of Agriculture, 2004).

Veterinary antibiotics and steroid hormones are often used for disease prevention and growth promotion in livestock. In unlined burial pits, both hormones and veterinary pharmaceuticals have the potential to leach out of the pits and contaminate the surrounding soils and waterways (Yuan et al., 2013). Burial pits, if not backfilled with soil in a timely manner, can fill with water, creating a bacterial hazard for wildlife (Henry, 2003).

b. Standard Procedures Alternative

Offsite rendering, fixed-facility incineration, and landfills would be expected to cause less of an impact to wildlife than unlined burial and open-air burning, so long as carcasses are transferred offsite in a timely manner, and proper requirements and recommendations are followed.

Lack of timely transfer of carcasses to offsite facilities presents wildlife hazards, especially in instances where the carcasses are infected with disease (Rahman et al., 2009). If there is an incident when carcasses are contaminated with biological, chemical, and/or radiological agents, the carcasses would be less likely to contaminate wildlife if they were removed promptly to an offsite location for disposal at a landfill or incineration.

Composting and landfills are known to attract scavengers, so precautions must be taken to manage carcasses effectively so that any biological, chemical, and/or radiological agents are not transferred to wildlife. Composting is effective at killing some pathogens (NABCC, 2004a) and, subsequently, reducing the risk to wildlife in the vicinity. However, if compost material is placed near surface waters, it could cause eutrophication, excessive enrichment of water bodies with nutrients. If eutrophication occurs, there could be a reduction in the biodiversity of fish and invertebrates as a result of changes in water and food quality, and decreased oxygen concentration (UNEP, n.d.).

Carcasses that are managed due to a recent radiological release are likely to be contaminated with radioiodine and/or radioactive cesium. Cesium is an analog (i.e., a chemical compound that is similar in structure to another compound) of potassium; it may accumulate in herbivores and carnivores via the potassium pathway (i.e., a channel for the passage of potassium ions), through consumption of contaminated carcasses or vegetation. Aquatic species may be more susceptible to cesium contamination than terrestrial species, though dilution will greatly reduce the impact. However, the ability of aquatic organisms to accumulate cesium is influenced by the salinity of the water and waterborne clay particles, which may sequester the radionuclide and reduce its absorption. Marine organisms are less susceptible to cesium than freshwater organisms (Avery, 1996).

As discussed within the sections on soil quality, pollutants (e.g., dioxin) may be released during burning of carcasses. The extent of any impacts to wildlife resulting from the settling of dioxin from incineration onto soil would be based on the number of carcasses incinerated, as well as State and Federal regulations that regulate emissions from incinerators. Fixed-facility incineration is, however, capable of thoroughly destroying TSE-infected carcasses (NABCC, 2004a).

If composting is used, physical and chemical changes would occur to soil quality. The changes could result in increased plant growth, thereby providing wildlife, in the vicinity, with additional food and habitat. Excessive nutrients; however, could be harmful to plants, decreasing wildlife’s food supply and habitat.

Pathogens may still be present in decomposed material after rendering, and could subsequently spread disease to wildlife (Auvermann et al., 2004). The byproducts of both rendered and composted carcasses may include~~:~~ pathogens that could spread diseases to animals. In addition, nitrogen and sulfur compounds from carcasses could leach into the ground water, impacting surrounding wildlife.

c. Impacts Common to All Alternatives

Under each alternative, carcasses may be piled while awaiting disposal. The piled carcasses could provide a temporary food source for wildlife, which could have positive or negative impacts, depending on whether the carcasses contain any biological, chemical, and/or radiological agents.

Soil and water sources could be contaminated throughout carcass management. Decomposition of animal carcasses could contaminate soil and surface or ground water, in turn impacting wildlife. Lead and euthanasia drugs from dispatched animals also are a concern to wildlife. Radiological materials in carcasses could contaminate water sources in the immediate vicinity of carcass management (Karam, 2005), which may harm individuals in a population in the short-term (Kollipara, 2014). Zoonotic pathogens, bacteria, and viruses could be transmitted to wildlife through surface water. Nearby wildlife may come into contact with contaminated soil or water; they also may come into contact with contaminated carcasses, especially scavengers and rodents that are attracted to the carcasses. Therefore, regardless of the management options used, carcasses should be made inaccessible to wildlife as quickly as possible, especially if livestock deaths are due to biological, chemical, and/or radiological agents.

Noise produced during carcass management may disturb wildlife and, in particular, breeding birds and mammals. Noise would be related to the use of machinery to place carcasses in a pile. Also, each treatment or disposal option also produces additional noise. For example, during composting, machinery used to create and turn windrows makes noise.

Carcasses may be piled in vegetated locations prior to disposal, and machinery used to move carcasses on premises may crush vegetation and compact the soils. This reduces the amount of available vegetation for wildlife; however, short-term trampling generally destroys the growing vegetation, but leaves the root systems intact for regrowth during subsequent growing seasons.

d. Potential Mitigations

The United Kingdom Environment Agency published an interim assessment of the impact of the FMD outbreak on the environment. The assessment concluded that no significant negative impacts to wildlife had occurred (NABCC, 2004a). Similarly, APHIS anticipates that carcass management alternatives will have minimal impacts on wildlife in the United States if BMPs are followed. Various potential effects from carcass management can be mitigated by promptly removing, storing, and disposing of carcasses. Exposure to lead ammunition can be reduced by ensuring that scavengers do not have access to carcasses. Proper burial and composting procedures can mitigate the spread of diseases, and eliminate the direct exposure to zoonotic pathogens. When complete thermal destruction of biological and/or chemical agents is possible, incineration may be used. In cases where Federal or State law prohibits this type of disposal, the impacts to soil, air, and water quality would not occur. Federal and State guidelines will also help minimize the potential for negative impacts to vegetation from methods such as onsite composting (NRCS, 2003a). Protecting soil, air, water, and vegetation will in turn minimize impacts to the surrounding wildlife.

2. Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C. 668–668c) prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle…[or any golden eagle], alive or dead, or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

The bald eagle has a widespread distribution in North America and is flourishing in the United States. The largest North American breeding populations are in Alaska and Canada, however, there are also significant bald eagle populations in the Great Lakes States, Florida, the Pacific Northwest, the Greater Yellowstone area, and the Chesapeake Bay region (FWS, 2013a).

According to the FWS (FWS, 2011), "[g]olden eagles (*Aquila chrysaetos canadensis*) can be found from the tundra, through grasslands, forested habitat and woodland-brushlands, south to arid deserts, including Death Valley, California. They are aerial predators and eat small to mid-sized reptiles, birds, and mammals up to the size of mule deer fawns and coyote pups." They also are known to scavenge and eat carrion. FWS estimates that there are 30,000 golden eagles across the United States (FWS, 2011). Bald and golden eagles move quickly to fresh carcasses and fend off other scavengers (Krueger and Krueger, n.d.).

It is conceivable that both bald and golden eagles could be found within the area that carcasses are managed during a mass animal health emergency. If carcasses are not properly disposed of, Eagles may be poisoned by the ingestion of livestock carcasses that have been euthanized with sodium pentobarbital (or other barbiturates) or with lead ammunition.

a. Sodium Pentobarbital and Other Barbiturates

FWS indicates that in recent years, there have been at least 50 documented eagle-poisoning incidents involving pentobarbital that have affected 139 eagles (Krueger and Kruger, n.d.). These poisonings were as a result of feeding on carcasses of euthanized farm animals, horses, or small animals left unburied or exposed in landfills (Krueger and Krueger, n.d.).

In January 1988, 29 wintering bald eagles were poisoned from feeding on the carcass of a cow euthanized with sodium pentobarbital in British Columbia, Canada (Langelier, 1993). When waterways are frozen and they cannot access fish, their primary food source, wintering bald eagles rely on prey robbery and scavenging to obtain food (Fischer, 1985; Knight and Skagen, 1988). “Many animals that ingest poisoned tissue are acutely intoxicated, become comatose, and are discovered dead lying beside the poisoned carcass. Others are unable to walk or fly short distances and are found staggering around the field or landfill, in adjacent fields or woodlots, near roost trees or in parking lots or other areas. Finally, a number of intoxicated victims may be killed by blunt trauma (wandering into traffic or falling from perches), predation, drowning, fatal mobbing attacks by other species, or electrocution after contact with power lines and poles” (Krueger and Kruger, n.d.). Any animal euthanized with a barbiturate must be properly disposed of to prevent bald and golden eagles from being poisoned by ingestion of contaminated carcasses.

b. Lead Ammunition

General impacts of lead on soil, air, water, and animals are discussed in chapter 4.M. Impacts of lead that are specific to concerns under the Bald and Golden Eagle Protection Act will be discussed below in order to ensure the Act was thoroughly considered.

The ingestion of lead from spent ammunition can kill birds and other wildlife (Bellrose, 1959; Eisler, 1988). Lead poisoning of eagles is a national and international problem. Secondary toxicity from consumption of lead poisoned or contaminated waterfowl is thought to be the predominant source of lead exposure for wintering bald and golden eagles (Pattee and Hennes, 1983; Nelson et al. 1989). As few as 10 pellets can result in lethal or sublethal impacts to bald eagles (Eisler, 1988). The United States banned the use of lead pellets for hunting waterfowl in 1991, and this has reduced lead levels and poisoning in waterfowl (Anderson et al., 2000). However, lead levels in eagles still remain high, likely from ingestion of white-tailed deer killed with lead ammunition (Cruz-Martinez et al., 2012).

From 1996 to 2009 in Hokkaido, Japan, 92 Steller’s sea-eagles (*Haliaeetus pelagicus*) and 37 white-tailed eagles (*Haliaeetus albicilla*) died from lead-poisoning as a result of ingesting lead ammunition in Sika deer carcasses (Saito, 2009). During the winter of 2013, FWS collected 58 bald eagle carcasses from the Upper Midwest; 60 percent of the eagles had detectable levels of lead, and 38 percent of them had lethal levels of lead. Most of the eagles with lethal lead concentrations also had corresponding clinical signs consistent with lead exposure. The likely source of lead is bullet fragments from deer carcasses and gut piles (FWS, 2014).

c. Potential Mitigations

The presence of bald and golden eagles across the United States makes it likely that eagles will be located in the vicinity of large carcass management operations. Therefore, expeditious management of carcasses can be a necessity if carcasses are contaminated with veterinary medications or lead ammunition. Many States require treatment and/or disposal within a short time interval after the discovery of a carcass. These requirements minimize the amount of time that scavengers and carrion-feeders feed upon carcasses. An additional mitigation for minimizing the time that eagles are able to feed upon carcasses includes only euthanizing as many animals as can be immediately managed. When carcasses are treated and/or disposed of, incineration is the best method to protect eagles from pentobarbital poisoning (Krueger and Krueger, n.d.).

If more animals are euthanized than can be immediately disposed of, APHIS can incorporate mitigations into its carcass management plans that reduce eagle exposure to lead and chemicals. The use of nontoxic shot would minimize the impacts to scavenging eagles. Siting carcass disposal sites away from known eagle breeding or wintering areas would minimize their access to carcasses. The use of a captive bolt, carbon dioxide, or a nontoxic injectable agent (e.g., potassium chloride) in combination with a nontoxic anesthetic is also acceptable to protect wildlife (Krueger and Krueger, n.d.).

Labels on euthanasia drugs should also be reviewed and closely followed. In 2003, the FDA added an environmental warning label to euthanasia solutions containing pentobarbital (FDA, 2003). The label states, "ENVIRONMENTAL HAZARD: This product is toxic to wildlife. Birds and mammals feeding on treated animals may be killed. Euthanized animals must be properly disposed of by deep burial, incineration, or other method in compliance with State and local laws, to prevent consumption of carcass material by scavenging wildlife."

In instances where large numbers of animals die naturally from weather-related disasters, the immediate management of animals is not as urgent, nor may it be possible. It is likely that these situations would provide a valuable food source to scavengers.

3. Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (16 U.S.C. 703–712) established a Federal prohibition, unless permitted by regulations, to pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird or any part, nest, or egg of any such bird. FWS released a final rule on November 1, 2013, identifying 1,026 birds on the List of Migratory Birds (FWS, 2013b). Species not protected by the Migratory Bird Treaty Act include nonnative species introduced to the United States or its territories by humans and native species that are not mentioned by the Canadian, Mexican, or Russian Conventions that were implemented to protect migratory birds (FWS, 2013b).

a. Sodium Pentobarbital and Other Barbiturates

Veterinary drugs such as sodium pentobarbital can negatively impact scavenging migratory birds (condors, vultures, hawks, crows, gulls, etc.). In particular, raptors have a low tolerance for barbiturate compounds. Barbiturate-intoxicated birds have varying degrees of consciousness and slow heart and respiration rates; death can result from ingestion of barbiturates (USGS, 1999).

b. Lead Ammunition

General impacts of lead on soil, air, water, and animal health are discussed in chapter 4.M. Impacts of lead that are specific to concerns under the Migratory Bird Act will be discussed below in order to ensure the Act was thoroughly considered.

The effects of lead ammunition on wildlife have been recognized since the 1870s (Rattner, 2008a). Young birds are the most vulnerable to the effects of lead consumption (Pinowski et al., 1994). Birds are exposed to lead at a low rate from contaminated soil, plants, and water. Birds, such as waterfowl, granivorous birds, and raptors are most frequently exposed to lead through direct ingestion of lead shot and bullets, lost fishing sinkers and tackle, and through consumption of prey wounded or killed with lead shot (Joseph, 2013; USGS, 2013). Birds also can be exposed to lead in areas with mining activities (Van der Merwe et al., n.d.).

Lead exposure in birds is dependent upon their feeding and grit ingestion habits. Ingestion rates of only one or two shots daily for several weeks can cause birds to suffer debilitating effects, including impairment of migratory behavior and death (Bellrose, 1959; Sanderson and Bellrose, 1986).

Even though nontoxic shot requirements were established for hunting waterfowl in 1991, lead is still used in ammunition for euthanizing livestock, as well as for upland hunting, shooting sports, and in fishing tackle. Raptors such as red-tailed hawks (*Buteo jamaicensis*) and great-horned owls (*Bubo virginianus*) that feed on game birds and mammals can succumb to lead poisoning from incidental ingestion of spent lead ammunition (Rattner et al., 2008a). Bullet fragments in gut piles and carcasses of hunter-killed wildlife also present hazards to scavenging birds

(Hunt et al., 2006; Knopper et al., 2006; Pauli and Buskirk, 2007). A study in British Columbia showed that 77.8 percent of carcasses were found by scavengers within 24 hours of death, demonstrating that the discovery of carcasses can be rapid (Peterson et al., 2001).

Vultures and condors are at an increased risk of lead poisoning due to their inability to regurgitate pellets from their gastrointestinal tracts (Eisler, 1988). Recent studies indicate that lead fragments found in hunted carcasses or gut piles are the main source of lead poisoning in California condors (Church et al., 2006).

Lead poisoning also has been reported in other upland birds, such as the American woodcock (*Scolopax minor*), sandhill crane (*Grus canadensis*), clapper rail (*Rallus longirostris*), and mourning dove (*Zenaida macroura*) (Fisher et al., 2006). Of these birds, mourning doves have the most significant risk of lead poisoning. This increased risk is due to cold-susceptibility in birds that consume lead and because they frequent habitats that are a high risk for lead exposure (Kendall et al., 1996).

Many States regulate carcass disposal to ensure that carcasses do not remain available to scavengers. Poor compliance with regulations, shallow burial, or improper disposal at landfills could result in access of carcasses to scavenging migratory birds (USGS, 1999).

4. Executive Order 13186: Protection of Migratory Birds

EO 13186 directs Federal agencies taking actions with a measurable negative effect on migratory bird populations to develop and implement a Memorandum of Understanding (MOU) with FWS that promotes the conservation of migratory bird populations. On August 2, 2012, an MOU between FWS and APHIS was signed to facilitate the implementation of this EO. The MOU provides APHIS with guidance to avoid and minimize, to the extent practicable, detrimental migratory bird habitat alteration or unintentional take during animal management activities.

General migratory bird stressors include artificial light, noise, and perches, chemical contamination, human disturbance, structural addition to the landscape, and vegetation manipulation or removal. Some of these stressors can be avoided during carcass management activities by minimizing the time in an area, carefully considering placement of carcass piles, and following BMPs for each carcass management method.

APHIS may opt to only euthanize as many animals as can be immediately disposed of in order to minimize the time that birds are able to feed upon carcasses. If more animals are euthanized than can be immediately disposed of, APHIS can incorporate mitigations into its carcass management plans that reduce migratory bird exposure to lead and chemicals.

APHIS should avoid using lead shot and bullets where carcasses may be scavenged. Carcasses shot with lead should be retrieved immediately or made inaccessible to scavenging A-birds. Any animal euthanized with a barbiturate must be properly disposed of to prevent scavenging migratory birds from being poisoned by ingesting contaminated carcasses. When carcasses are disposed of, incineration is the best method to protect scavengers from barbiturate poisoning (Krueger and Krueger, n.d.).

I. Endangered Species Act

Section 7 of the Endangered Species Act (ESA) and ESA's implementing regulations require Federal agencies to consult with FWS and/or the National Marine Fisheries Service (NMFS) to ensure that their actions are not likely to jeopardize the continued existence of threatened or endangered species, or result in the destruction or adverse modification of critical habitat.

Carcasses can provide an important food source to carrion-eaters and scavenger species and, in certain cases, removal of this food source can be detrimental. For instance, in Europe, changes in carcass management policies made carcasses unavailable to vultures, resulting in detrimental effects on their populations (Margalida et al., 2010). Despite the potential benefits of carcasses to scavengers and carrion-feeders, there are many potential adverse effects to species from consuming carcasses if they are contaminated with veterinary medications, lead ammunition, or are diseased. Federally listed, proposed, and candidate scavenging animals in the United States include species such as Canada lynx (*Lynx canadensis*), grizzly bear (*Ursus arctos horribilis*), San Joaquin kit fox (*Vulpes macrotis mutica*), San Miguel island fox (*Urocyon littoralis littoralis*), Santa Catalina Island fox (*Urocyon littoralis catalinae*), Santa Cruz Island fox (*Urocyon littoralis santacruzae*), Santa Rosa Island fox (*Urocyon littoralis santarosae*), gray wolf (*Canis lupus*), red wolf (*Canis rufus*), fisher (*Martes pennanti*), and California condor (*Gymnogyps californianus*).

1. Potential Impacts on Federally Listed Species

a. Poisoning from Sodium Pentobarbital and Other Barbiturates

Federally listed scavenging/carrion feeding animal species can be poisoned by feeding on carcasses that have been euthanized with sodium pentobarbital or other barbiturates. This can occur when euthanized animals are left in the field or improperly buried or landfilled.

b. Veterinary Drug Poisoning

Veterinary drugs are frequently dispensed to livestock in the United States. FDA's Center for Veterinary Medicine regulates the manufacturing and distribution of animal drugs, pharmaceuticals, and feed additives. These products have labels that include safety and disposal information, and slaughter withdrawal times, if necessary. However, veterinary drugs that are used to treat livestock have been known to cause adverse effects to scavenging birds when they ingest contaminated carcasses. Ingestion of carcasses treated with antimicrobials (primarily fluoroquinolones) contributed to breeding failure in the endangered bearded vulture in Europe (Blanco and Lemus, 2010). In South Asia, the veterinary use of a nonsteroidal anti-inflammatory drug (NSAID) diclofenac caused a decline in the endangered vultures (*Gyps bengalensis, Gyps indicus,* and *Gyps tenuirostris*) because of their feeding on livestock carcasses treated with the drug before death (Green et al., 2006). The manufacture of veterinary diclofenac is banned in South Asia, and has been replaced by the vulture-safe drug meloxicam (Swan et al., 2006).

There is evidence that the ban on veterinary diclofenac is resulting in a reversal of vulture population declines in South Asia (Jamshed et al., 2012). However, diclofenac and other veterinary NSAIDs may still pose threats to vultures in Africa, South Asia, and other locations (Naidoo et al., 2009; Naidoo et al., 2010). Some NSAID drugs are available for veterinary use in the United States, but the only NSAID drugs approved for use in cattle is flunixin meglumine (Banamine®). However, no *Gyps* species vultures that are affected by NSAID toxicity are native to North America; the native turkey vulture (*Cathartes aura*) is unrelated to *Gyps* species vultures, and is highly tolerant to diclofenac (Rattner et al., 2008b).

c. Lead Poisoning

General impacts of lead on soil, air, water, and animal health are discussed in chapter 4.M. Impacts of lead that are specific to concerns under the Endangered Species Act will be discussed below in order to ensure it was thoroughly considered.

As previously mentioned, the ingestion of lead from spent ammunition can kill birds and other wildlife (Bellrose, 1959; Eisler, 1988). The endangered California condor is the largest flying land bird in North America, and is an opportunistic scavenger feeding only on the carcasses of dead animals (FWS, 1996). Most of the condor diet consists of dead cattle, domestic sheep, ground squirrels, mule deer, and horses (FWS, 1996). It was nearly driven to extinction, in large part, because of lead poisoning (FWS, 1996), and poisoning from lead-based ammunition continues to be a major threat (Finkelstein et al., 2012). Captive breeding programs and reintroduction into the wild in locations in California, Arizona, and Baja California in Mexico have been successful in bringing back the condor from the brink of extinction, but only with intensive management. The future of the California condor is uncertain without elimination or substantial reduction of lead poisoning (Cade, 2007; Finkelstein et al., 2012).

Fisher et al. (2006) list other species of international conservation status known to have ingested or been poisoned by lead shot or bullet fragments in the wild including white-tailed eagle (*Haliaeetus albicilla*), northern bobwhite quail (*Colinus virginianus*), Stellar's sea-eagle (*Haliaeetus pelagicus*), Spanish imperial eagle (*Aquila adalberti*), whooping crane (*Grus americana*), and white-rumped vulture (*Gyps bengalensis*). Of these, the whooping crane is federally listed as endangered in the United States.

d. Spread of Disease

Scavengers feeding on disease-infected animal carcasses may spread diseases to other wildlife species, such as from feeding on deer carcasses infected with CWD (Jennelle et al., 2009). While the management of wild deer carcasses is not within the scope of this EIS, the management of captive deer raised as livestock could fall within the scope. Scavengers could spread CWD to animals within the family Cervidae, which are susceptible to CWD. Federally listed cervids that would be susceptible include Key deer (*Odocoileus virginianus clavium*), Columbian white-tailed deer (*Odocoileus virginianus leucurus*), and woodland caribou (*Rangifer tarandus caribou*).

e. Ground-Nest Predation

Carcasses may attract facultative scavengers, resulting in an increase in nest predation by those scavengers in areas surrounding the carcass disposal site (Cortés-Avizanda et al., 2009). Federally listed ground nesting birds that could be affected by facultative scavengers include the piping plover (*Charadrius melodus*), least tern (*Sterna antillarum*), California least tern (*Sterna antillarum browni*), California clapper rail (*Rallus longirostris obsoletus*), light-footed clapper rail (*Rallus longirostris levipes*), Yuma Clapper rail (*Rallus longirostris yumanensis*), roseate tern (*Sterna dougallii dougallii*), and Florida grasshopper sparrow (*Ammodramus savannarum floridanus*).

2. Human-Animal Conflicts

The threatened grizzly bear (*Ursus* a*rctos horribilis*) is a scavenger, and is attracted to livestock carcass disposal sites; this can increase the likelihood of human-grizzly bear conflicts, leading to grizzly bear deaths (Wilson et al., 2006).

3. Adverse Modification of Critical Habitat

Critical habitat for federally "listed species consists of (1) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the [Endangered Species] Act, on which are found those physical or biological features (constituent elements) (a) essential to the conservation of the species and (b) which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the [Endangered Species] Act, upon determination by the Secretary [of the Interior] are essential for the conservation of the species" (FWS, 1998).

Placement of carcass management sites could adversely modify the designated critical habitat of a listed species if it unfavorably affects the critical habitat's basic elements that benefit a listed species. These are the physical and biological features of the habitat that are essential to the conservation of the species including space for individual and population growth and normal behavior; food, water, air, light, minerals or other nutritional or physiological requirements; cover or shelter; sites for breeding; and habitats free from disturbance (FWS, 1998). The disturbance and habitat alteration from burial site digging, carcass burning, or carcass composting could cause adverse effects to critical habitat of listed species.

4. Protection of Federally Listed Species and Critical Habitat

Although statutes regarding carcass management methods are promulgated at the State and local level, efforts should be made to ensure that scavengers do not have access to carcasses, especially if euthanized with a barbiturate, lead ammunition, or infected with a transmissible disease. This may be accomplished through deep burial, incineration, rendering, or other method in compliance with State and local laws to prevent scavenger consumption. Immediate deep burial, captive bolt, and nontoxic injectable euthanizing agents (e.g., potassium chloride) are also protective of wildlife (Krueger and Kruger, n.d.).

As carcass management options are considered, occurrence of federally listed species and critical habitat in the area must be considered; section 7 consultation with the FWS and/or NMFS may be necessary, depending on the location. Carcass management sites must not be created within the proposed or designated critical habitat of listed species without consultation with FWS and/or NMFS.

J. Fuels

The use and combustion of petroleum-based fuels will lead to environmental impacts. Petroleum-based fuels, (e.g., gasoline and diesel fuel) consist of hydrocarbons and other organic compounds. Burning such fuels can lead to byproducts that may contribute to global warming, as well as smog, acid rain, and human health impacts. Fuels also add additional cost to carcass management, and will need to be considered during the decisionmaking process.

All carcass management options will need fuel (e.g., gasoline or diesel fuel) to run machinery for the onsite collection and movement of carcasses. Offsite disposal options, under the standard procedures alternative, will need additional fuel for offsite transportation trucks. The type of truck, weight transported, number of trips, and the distance to the endpoint will all determine the amount of fuel that will be necessary. Management options that ignite material (i.e., open-air burning and incineration) will require additional fuels such as coal, diesel, natural gas, or propane. Rendering plants require fuel to run machinery as well. Landfills, composting, and burial would require additional fuel for machinery for digging or to turn or move material at the management sites. (See table 4–3 for a very general summary of fuel use throughout carcass management.) When a mass animal health emergency occurs, a more specific analysis regarding the use of fuel, fuel type, and potential environmental and human impacts must be considered.

Table 4–3. Summary of Fuel Use During Carcass Management

Disposal Option	Onsite Transportation Fuel	Additional Offsite Transportation Fuel	Additional Fuel for Treatment/ Processing
Onsite Unlined Burial	X		
Onsite Open-Air Burning	X		X
Onsite Composting	X		X
Offsite Rendering	X	X	X
Offsite Landfill	X	X	X
Offsite Incinerator	X	X	X

K. Decontamination

The primary impacts of concern during decontamination are related to disinfection. Under the no action alternative, there may be less use of disinfectants than under the standard procedures alternative as it is likely that there will be fewer vehicles and items needing treatment prior to movement on- and offsite. Disinfectant solutions will be used when carcasses are infected with pathogens. Surfaces and items that could have been cross-contaminated need to be disinfected. Disinfectant are sometimes applied directly to carcasses with infectious diseases (e.g., AI) before they are handled for disposal (FAO, 2005; Pollard et al., 2008). After a natural disaster, disinfectants are likely to be used when water sanitation issues arise.

Potential environmental impacts from the use of disinfectants are both positive and negative. Disinfectants can reduce pathogen exposure pathways, protecting animal and human health. Disinfectants are potentially harmful to beneficial micro-organisms, for example, beneficial soil micro-organisms. Disinfectants may impact water quality if soils are vulnerable to leaching and the chemicals are used in close proximity to surface or ground water or used near wells. There is a potential for disinfectants to come in contact with vegetation, causing contamination or damage (Engel et al., 2004). Disinfectants used during and after carcass management also have the potential to negatively impact wildlife. A review of the 2001 FMD outbreak in the United Kingdom determined that there were three large fish kills associated with pollution created by the release of disinfectants (Nutsch and Spire, 2004).

The use of disinfectants is regulated by EPA through their pesticide registration process under FIFRA. Label directions, including the appropriate concentrations, use sites, and product disposal are meant to protect pesticide applicators and the surrounding environment. Workers who prepare and apply disinfectant solutions may develop skin, eye, or respiratory irritation, or damage after exposure. For this reason, applicators should follow all EPA-approved label safety precautions and wear appropriate personal protective equipment (e.g., gloves and goggles). With proper use of protective equipment, the exposure to workers from disinfection solutions is expected to be minimal. Exposure by the general public is unlikely if the site is secured and runoff is prevented from entering into lakes, streams, and ponds.

Applicators should ensure that an appropriate disinfectant is selected on the basis of the target pathogen; the benefits of using the disinfectant are weighed against any potential environmental consequences (Bruins and Dyer, 1995). Many SOPs for disinfectant application include methods to collect and dispose of runoff and residue. Applicators should ensure any residual product is contained or collected and properly disposed of to reduce any potential impacts within the soil or nearby water. If these procedures are not properly followed, it is possible for disinfectants to enter the ecosystem and cause contamination or damage (Engel et al., 2004).

L. Transportation

Onsite transportation for any of the alternatives may cause an increase in soil compaction and damage to vegetation (see discussions within the soil quality and vegetation sections). Offsite transportation is not expected to increase soil compaction or damage to vegetation because preexisting roads would be used.

Transportation biosecurity applies primarily to offsite disposal options (fixed-facility incineration, rendering, and landfill) included in the standard procedures alternative~~s~~. Biosecurity is a primary concern to human health and the environment; the potential exposure to infected or contaminated carcasses may occur from accidental releases during transportation. If transportation is properly planned, exposure to the general public and the surrounding environment is unlikely because livestock carcasses should be transported in covered, leak-proof containers such as lined roll off containers, lined dump trucks, and the route(s) for transport of animal carcasses are determined ahead of time (CFSPH, 2012).

A 2014 risk assessment, conducted by the University of Minnesota, evaluated the risk of infecting susceptible livestock from the movement of FMD-infected carcasses from an FMD-infected premises. The assessment found that the risk of FMD infection of susceptible livestock was negligible when using a standard rendering truck (tailgate sealed and tarp covered) and bio-containment bags constructed of a thermally bonded layering of polypropylene, and featuring an industrial zippering system. The assumptions included, but were not limited to, the exterior of the truck being properly cleaned and disinfected prior to leaving the infected premises, and the driver did not come into contact with any infected materials (University of Minnesota, 2014).

Selecting a travel route through areas with limited or no population is the best way to limit human exposure and avoid conflict with the general public. Other transportation safety practices include minimizing the number of stops required, ensuring close proximity to the infected site to limit refueling, and conducting a vulnerability assessment that will help determine the most likely scenarios that are possible for a breakdown in the transportation process (Pullen, 2004).

M. Lead

For the purpose of this EIS, the use of euthanasia is not considered to be part of carcass management. However, reviewing the potential impacts of lead within carcasses that must be disposed of during a mass animal health emergency is within the scope of this EIS.

Depopulation of livestock using lead shot during a mass animal health emergency could become a source of lead in the environment if the carcasses are improperly managed. Lead-based ammunition may be used to kill animals that are contaminated with biological, chemical, and/or radiological agents. Lead from ammunition has a long half-life in soil, and would not be expected to degrade in quantities that would result in significant impacts to soil quality or to plants that may grow in composted areas. Degraded lead is typically bound to soil particles and, in particular, organic matter. The amount of lead that becomes soluble in soil is usually very small (0.1–2.0 percent) (EPA, 2005). In the absence of other environmental factors, lead released to soil usually binds to soil particles and remains immobile in the top 6 inches of the surface soil (Cullen et al., 1996; Hue, 2002). The dissolution of lead compounds in the crust material releases lead to the environment (EPA, 2003). This results in limited bioavailability for plant uptake due to the strong adsorption of lead-to-soil particle and, in particular, in the presence of high organic matter (Miller, 2008).

Under the no action alternative, there is the potential for soil and air contamination by lead when lead-contaminated carcasses are managed. Lead from contaminated carcasses placed in unlined burial sites may move into the soil. Open-air burning can release lead as an air pollutant, and metals in the ash after burning may leach into soils. These carcass management options may, in turn, put humans and other animals at risk.

Under the standard procedures alternative, fixed-facility incineration facilities include physical measures to remove lead from emitted gas prior to release into the air. Incinerator ash with lead can be buried in a lined landfill to avoid soil contamination. Rendering byproducts with lead could also be buried in a lined landfill.

The land application of compost derived from carcasses containing lead ammunition may result in elevated lead concentrations wherever the composted material is applied. Lead may also be taken up by plants grown in those composted areas. Composting using poultry waste, as well as other amendments, has been shown to reduce the availability of lead to move from the soil into plants and water (Hashimoto et al., 2008; Siebielic and Chaney, 2012).

1. Livestock

Lead from euthanized carcasses may be toxic to surrounding livestock, leading to neurological problems. Cattle are the most susceptible to lead, while pigs are the least susceptible (Siddiqui et al., 2008). Lead is absorbed into the blood and soft tissues and distributed to the bones. “In ruminants there is a tendency for metallic lead particles to settle in the reticulum; poisoning results from the gradual conversion of lead particles to soluble lead acetate due to the acidity of the fore stomachs. Young calves are more susceptible to lead poisoning because of their innate curiosity, their active calcium absorption mechanism and the fact that milk and milk-replacer diets promote lead absorption” (Siddiqui et al., 2008).

Animals euthanized with lead ammunition should not be used as feed for other species. Unless all pieces of ammunition are removed, lead is likely to remain in the tissues, and become dispersed within a rendering batch. Consumption of the products of rendering should be avoided because of the potential for lead poisoning (Auvermann et. al., 2004).

2. Wildlife

The effects on wildlife of carcasses contaminated with lead-based ammunition have been recognized for more than a century (Rattner, 2008a). Carcasses provide a needed food source for scavengers, raptors, and carrion-feeders, however there are many potential adverse effects to species from consuming carcasses contaminated with lead. Ingestion of lead from spent ammunition can kill birds and other wildlife (Bellrose, 1959; Eisler, 1988). Low levels of lead in the environment can become concentrated in the food chain leading to toxic impacts. Lead causes a decrease in the amount of hemoglobin in the red blood cells, causing critical anemia. Reduction in red blood cells can cause kidney impairment, liver dysfunction, gastro-intestinal problems, and neurological damage (Joseph, 2013). Lead exposure can also affect hematologic, gastrointestinal, cardiovascular, and renal systems (Joseph, 2013).

3. Mitigations

An emphasis on the use of non-lead ammunition for euthanasia during a mass animal health emergency would reduce the potential for lead contamination in the environment. Exposure to lead can be reduced by ensuring scavengers do not have access to carcasses, however APHIS should avoid using lead-based ammunition when carcasses may be scavenged. Animals killed with lead ammunition should be retrieved immediately or made inaccessible to scavenging birds. State and local laws usually acknowledge the need to ensure scavengers do not access carcasses, therefore controls are likely to exist at offsite disposal locations. In situations where the number of euthanized animals exceeds the immediate disposal capacity, APHIS carcass management plans should consider lead mitigation measures if firearms with lead ammunition were used for depopulation.

Burial procedures must sufficiently preclude wildlife's access to lead-contaminated carcasses. Carcasses need to be adequately punctured and/or buried to a proper depth for two major reasons: (1) gas buildup during decomposition must not unearth the carcasses, and (2) burial must be deep enough so other animals do not unearth the carcasses. The liner systems in commercial landfills prevent leachate discharge to the environment, thereby preventing lead in landfilled carcasses from impacting the environment.

N. Climate Change

The CEQ 2014 guidance for GHG emissions and climate change impacts recommends that agencies consider both the potential effects of a proposed action on climate change, as well as the implications of climate change for the environmental effects of a proposed action. Therefore, this section examines the impacts of climate change from two different perspectives, including (1) how could climate change be impacting carcass management and, (2) how could impacts from various carcass management alternatives impact climate change. Climate change can result in direct, indirect, and cumulative environmental effects which may result in more numerous mass livestock mortalities. Secondly, carcass management alternatives may have an impact on total GHG emissions. This EIS does not quantify GHG emission levels from any specific management activity because emissions from offsite disposal options vary with the technology at each site. Determining what portion of the emissions came from 50 tons of carcasses would depend on what specific technology was used. Emissions associated with onsite management options are identified where the information exists. GHG emissions associated with mass livestock mortality incidents are compared to overall agricultural sector GHG emissions in order to provide perspective (see appendix C).

1. Potential Impacts of Climate Change on Carcass Management

APHIS anticipates that ongoing climate change is likely to create more mass animal health emergencies per year as the country experiences an increase in temperature extremes (including extreme cold), tropical storms, high precipitation weather events, and/or drought conditions. Temperature extremes associated with climate change directly affect livestock production, reproduction, and resistance or susceptibility to disease (Collier and Zimbelman, 2007), which could increase the number of mortalities per year. These factors are likely to exert diverse effects on livestock production.

Climate change is likely to induce the same direct and indirect impacts on carcass management regardless of which alternative is selected. The following environmental changes may impact livestock health which, in turn, may impact carcass management, and are common to all alternatives:

- Temperature and rainfall changes could impact livestock feed and water availability

- Temperature and rainfall changes could impact conditions for certain pathogens or vectors (e.g., mosquitos)

- Temperature extremes could cause direct stress to livestock.

Examples and explanations of the above listed impacts are discussed below. (Readers should note that there could be environmental changes that cause both positive and negative impacts to livestock health.)

Land use and land cover will be affected differently in different parts of the world as a result of climate change (Nardone et al., 2010). Climate change may alter locations of livestock production in the United States based on changed patterns of vegetation used for grazing across the country, and shift away from marginal lands used for cropping (Drummond et al., 2012). There may also be changes in the availability of feed. These effects are likely to continue regardless of which carcass management alternative is selected because feed issues precede the occurrence of mortalities for management.

Changes in temperature, rainfall amounts, and rainfall variability directly affect feed quantity by triggering periods of feed scarcity, especially in dryland areas (Middleton and Sternberg, 2013). Under climate change conditions, the process of desertification is expected to reduce the carrying capacity of rangelands and the buffering ability of pastoral systems (Nardone et al., 2010). Climate change-induced drought in the United States during 2011–12 was record setting in severity, extent, and persistence (Grigg, 2014). Climate change-induced drought demonstrates the interdependency of water-using sectors, and how chain reactions ripple through the economy (Grigg, 2014). Drought increases crop prices, farmland values, and feed costs. As pastures and grasslands dry up, the high price of hay leads ranchers to send herds to slaughter. Responses to drought typically aim to mitigate adverse effects from water shortages through augmenting the water supply, reducing demand, and mitigating losses; however, the recent drought was met with adjustments in crop yields and prices, regional trade patterns, and medium- to long-term changes in the livestock industry (Grigg, 2014). It is conceivable that increases in drought frequency (e.g., from 1 year in 5 to 1 year in 3) could set herd sizes on rapid and unrecoverable declines (Thornton et al., 2014). Drought-induced reductions in herd size may be reversed when ranchers perceive their resources can profitably support a larger herd size.

Changing seasonal grazing migrations are among the strategies deployed to mitigate drought effects in Africa (Middleton and Sternberg, 2013), however, this is not an option for U.S. concentrated feeding operations. Instead, this country can meet this challenge by continuing efforts to optimize crop productivity and farm operations, improving forecast models, and developing extension services (Nardone et al., 2010). In U.S. pasture systems, crop/livestock diversification is an adaptation option, along with use of technologies such as remote sensing to evaluate feed and water availability, assess animal migration effects, and modify feeding strategies based on local conditions (Nardone et al., 2010).

Currently, climate conditions lead to estimates of annual heat stress loss of \$1.7 to 2.4 billion in the U.S. livestock sector (Suddick et al., 2013). In general, the comfort zones for most domesticated livestock species range between 50 to 86 °F (10 to 30 °C). At temperatures below 50 °F, maintenance requirements for food can increase by up to 50 percent, while above 86 °F, animals reduce their feed intake 3 to 5 percent for each additional degree of temperature (Thornton et al., 2014). Extreme high temperatures have led to mass mortalities in the United States during summer months. It is reasonable to think this trend would continue and potentially increase in the future.

To avoid heat stress, herds may be housed indoors, which decreases opportunities to act naturally and exercise, leading to lameness (Hristov, 2012). To date, altering the environment where animals are raised is an effective but costly solution to the problem of heat stress. Under climate change conditions, herd management and genetic selection would be used to improve the ability of livestock to cope with environmental stresses, which may include the observable characteristics (e.g., behavior) responses that occur during acclimation (Nardone et al., 2010). Accomplishing improved thermotolerance without adversely affecting production becomes an important goal under conditions of continuing climate change (Collier and Zimbleman, 2007).

Indirect and cumulative effects of climate change also are expected to arise from climate change-induced alterations of pathogen distributions (Altizer et al., 2013). One source of evidence relies on data for life-cycle parameters being superimposed on changing climatic zones. For example, a highly suitable habitat for tick (*Rhipicephalus annulatus*) carriers of cattle fever tick diseases currently is predicted for southern Texas and Arizona; however, models based on future climate data predict a sizeable expansion of habitat to include all of Texas and the Southern United States, including Florida (Giles et al., 2014; Pérez de León, 2012).

The cattle fever ticks infest cattle and occasionally horses, mules, sheep, goats, or deer while spreading (vectoring) protozoan parasites that cause babesiosis (Texas fever, tick fever, redwater, or bovine piroplasmosis). It is these blood parasites that are likely to cause mass mortalities (Barros and Fighera, 2008; Cantu-C et al., 2009). Outbreaks of the mosquito-borne disease, Rift Valley fever, are coupled with patterns of persistent and above-normal rainfall and temperatures that enable vector habitats to flourish (Anyamba et al., 2012). Climatic variables combine to affect the physiology, behavior, development, fertility, and mortality of hosts and parasites in nonlinear and sometimes conflicting ways (Altizer et al., 2013). As a result, understanding of the cumulative influence of climate on disease outcomes often is elusive (Altizer et al., 2013). Others argue there currently is no convincing evidence that climate change inevitably brings worse animal and human health in the short term (Perry et al., 2013).

Types of potential climate change-induced indirect effects vary widely. Indirect effects from flooding and extreme precipitation can encompass major releases of reactive nitrogen as water drains from fields, nitrous oxide gas releases from wet soil, and nitrates being flushed from agricultural systems (Suddick et al., 2013). Another indirect effect may arise from increases in temperature and moisture in feed, leading to increased mycotoxins in animal diets (Bryden, 2012; Nardone et al., 2010). While increases in mycotoxin concentrations may reduce animal growth rates, interfere with immunologic responses, and increase susceptibility to infections, these indirect impacts generally are below levels causing acute disease (Nardone et al., 2010) or causing sudden mass deaths.

2. Potential Impacts of Carcass Management on Climate Change

Living animals produce GHGs as part of their normal metabolic activities, estimated at 8.1 percent of U.S. GHG emissions in 2012 (EPA, 2014f). These emissions occur through respiration (carbon dioxide), flatulence (methane), and the production of manure (methane, nitrous oxides, and ammonia). The amount of annual carbon dioxide and methane emissions from living livestock greatly exceeds the 25,000 metric tons of emissions threshold for analysis suggested by the CEQ (CEQ, 2010), as discussed in chapter 3, section c. After a mass mortality event, there is an immediate overall reduction in U.S. herds, which means a temporary reduction in the total GHG emissions from U.S. livestock. Any temporary decrease in emissions arising from the death of animals can be viewed as a short-term improvement in reducing GHGs. APHIS anticipates there would be no net decrease in GHG emissions over the long term. The immediate reduction would most likely be offset by the eventual emissions due to transporting carcasses, various management options, and emissions that will be produced as carcasses decay over time or are processed.

When animals die, all of their accumulated biomass decays over time, and a portion of these decay products may be released as GHGs. Market forces and indemnity programs are expected to influence herd or flock replacement rates and, consequently, the rate of any subsequent return to pre-emergency GHG emissions levels from U.S. livestock.

Below is a summary of the different types of GHG emissions (table 4–4). Each carcass management option is associated with some quantity of GHG emissions (appendix C, table C-1). How carcasses are managed creates different types and amounts of GHG products which, in turn, lead to different potential impacts on climate change.

Table 4–4. Greenhouse Gas Emissions Associated with Carcass Management

Method	Potential GHG Emissions
Unlined burial	Carbon dioxide, ammonia, methane
Open-air burning	Carbon monoxide, nitrogen oxides, sulfur dioxide, Particulates
Composting	Carbon dioxide, methane, nitrous oxide, ammonia
Rendering	NA
Incineration	Potential for hydrocarbon gases and particulates
Landfill	Carbon dioxide, nitrogen oxides, methane

Using certain management methods may decrease emissions and/or disperse emissions over a greater time. The quantity of emissions associated with the movement of carcasses depends on the type of vehicles, the numbers of vehicles, how long they are on the road, and the distance to the final destination. These factors can be determined at the site-specific project level where the available vehicle fleet and distances to existing facilities can be determined and compared. In general, the relative impact ranking for each disposal method needs to be considered in conjunction with the emissions associated with transport (see appendix C). If the volume of carcasses is great and the time frame for management is short, because of the potential for disease dissemination, concerns about impacts to climate change may be of lower priority.

O. Cumulative Impacts

CEQ defines cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR part 1508.7). CEQ states that increasing evidence suggests that the most devastating environmental impacts may not result from the direct impacts of an action, but from the combination of minor impacts of multiple actions over time (CEQ, 1997).

Impacts to humans and the environment from carcass management activities, during a mass animal health emergency, are inevitable. Provided that the proper management options are chosen and the proper mitigations are in place, impacts can be minimized. However, under NEPA, the environmental impacts of managing 50 tons of carcasses or more during a mass animal health emergency must be analyzed in conjunction with the environmental impacts of previous and current actions, as well as any potential future actions in the area.

Issues discussed below are of primary concern when considering potential cumulative impacts during a mass animal health emergency. However, a site-specific analysis of the cumulative impacts must be done. Worst-case scenarios are described in order that decisionsmakers be aware that current environmental conditions at carcass management sites could already be compromised, and this should be considered in context of any potential for additional impacts from managing carcasses.

1. Environmental Quality

Current farming practices impact the environment. However, depending on the scale of the farm and their management practices, the level of impacts to the soil, air, and water can vary significantly. When the decision is being made to use specific management options, any potential programs or actions in the area of the mass animal health emergency must be recognized and considered in a site-specific EA. This information should assist in determining a carcass management plan.

Farming has undergone significant changes in recent decades with the rise of industrial farm animal production (IFAP). Numerous small, independent farms have been replaced with large farming operations. IFAP is supported by large, concentrated animal feeding operations (CAFOs) that are used for growing food animals. EPA has defined CAFOs as an agricultural enteprise where animals are kept and raised in confined situations. CAFOs congregate livestock, feed, manure and urine, dead animals, and production to a limited land area. Feed is brought to the livestock rather than livestock grazing or seeking food. (EPA, 2014g).

IFAP has had important environmental and public health implications (Halden and Schwab, 2008). Halden and Schwabindicate that the three root causes of environmental degradation from IFAP are the large volume of animal waste produce, the lack of appropriate management and disposal of these materials; and the unsustainable water usage and soil degradation associated with feed production (Halden and Schwab, 2008). More animal waste is produced today than ever, and it is done so within a small area at a limited number of large farms (Halden and Schwab, 2008). The animal waste contains plant nutrients such as nitrogen and phosphorous; pathogens such as *E. coli*, growth hormones, antibiotics (Hribar, 2010); as well as pharmaceuticals (Burkholder et al., 2007). While human waste is treated through sewage treatment plants; livestock waste is not treated for these contaminants (Hribar, 2010). Ground application of untreated manure is one of the most common disposal methods for animal wastes. If the land application of these wastes is not performed in accordance with an approved nutrient management plan, the soil can become overloaded with nutrients and contaminants (Hribar, 2010).

Soil, air, and water quality may also be impacted by the leachate or air particulates from managing routine carcasses onsite. CAFOs result in large volumes of non-emergency mortalities requiring regular and prompt management. For example, in poultry production operations, a relatively constant percentage of the flock will die daily from congenital defects, accidents, and equipment failures (Blake et al., 2008). A flock of 50,000 broilers grown to 49 days prior to slaughter will produce 2.4 tons of carcasses (Blake et al., 2008) that must be managed. During 2010, approximately 1.7 million cattle died from nonpredator causes (APHIS, 2010). Nonpredator deaths were caused by respiratory problems, weather-related causes, digestive problems, mastitis, and calving problems (APHIS, 2010). These animals must be routinely managed, and are often disposed of on the farm.

Additional Federal, State, or local actions may be taken on a farm, potentially adding incremental environmental impacts. USDA, other Federal agencies, or State and local government agencies may have conducted, or may conduct in the future, programs or actions within the area that could, combined with carcass management activities, significantly impact the environment. For example, APHIS and States have implemented a feral swine program that may have to manage large numbers of swine carcasses in a small area. A property that is already managing a large amount of feral swine carcasses, may be forced to move livestock carcasses during a mass animal health emergency offsite because the additional environmental risks could be too great.

a. Soil Quality

Livestock can increase erosion and cause soil compaction, which can decrease water infiltration and increase surface water runoff (Krueger et al., 2002). In addition, large farmlands and rangelands typically handle noninfectious loads of carcasses (routine disposals) within available space on their lands. Animal carcasses may routinely be buried or composted on the farm; poultry producers may use composting or small-capacity onsite incinerators for their routine mortalities (Blake et al, 2008). CAFOs may involve year-round land application of excess manure containing nutrients, chemicals, and pathogens around feeding operations (Halden and Schwab, 2008; Hribar, 2007). That said, EPA and States regulate the management of manure from CAFOs. For example, in Wisconsin, regulations state, "The department also recognizes the benefit of manure applied to land for its fertilizer and soil conditioning value, and encourages the management and use of these materials in this manner. Only those animal feeding operations that improperly manage their wastes and, as a result, cause ground water or surface water pollution or that fail to comply with applicable performance standards and prohibitions or those operations that are CAFOs will be regulated…" (WDNR, 2013).

(i) No Action Alternative

Under the no action alternative, there is the potential for cumulative impacts to soil quality to be significant, when added to various impacts due to CAFOs, routine carcass disposal, and/or other actions that have been taken on the site of the mass animal health emergency. Unlined burial and/or open-air burning during a mass animal health emergency must take into account actions that have taken place or will take place on the site and either mitigate the carcass management actions to decrease cumulative impacts, or move carcass management activities offsite.

(ii) Standard Procedures Alternative

The potential for cumulative impacts to soil quality under the standard procedures alternative are expected to be minimal. As per discussions throughout chapter 4, unlined burial and/or open-air burning have the potential to contribute more environmental impacts to soil than offsite rendering, landfill, and fixed-facility incineration. Offsite facilities take into consideration previous and current disposal activities, and deny the acceptance of carcasses that cannot be adequately processed according to regulations. Composting is onsite and not at regulated facilities, so proper mitigations must be used to ensure minimal cumulative impacts to soil quality.

b. Air Quality

CAFOs release of significant quantities of gaseous and odorous air emissions, as well as particulates and bio aerosols containing micro-organisms and human pathogens (Halden and Schwab, 2008 and Hribar, 2007). The most commonly detected pollutants found in the air around CAFOs are ammonia, hydrogen sulfide, methane, and particulate matter(Hribar, 2007). When choosing a carcass management option, any potential environmental impacts must be considered in conjunction with the current air quality.

(i) No Action Alternative

Under the no action alternative, there is the potential for cumulative impacts to air quality to be significant when added to various impacts due to CAFOs, routine carcass disposal, and/or other actions that have been taken on the site of the animal health emergency. Unlined burial and open-air burning must take into account actions that have taken place or will take place on the site. If significant impacts are anticipated, the carcass management actions should be mitigated to decrease potential cumulative impacts or carcass management activities should be moved offsite.

(ii) Standard Action Alternative

The potential for cumulative impacts to air quality under the standard procedures alternative are expected to be minimal. As per the discussions throughout chapter 4, unlined burial and open-air burning have the potential to contribute more environmental impacts to air quality than offsite rendering, landfill, fixed-facility incineration, and composting. Offsite facilities take into consideration previous and current disposal activities, and deny the acceptance of carcasses that cannot be adequately processed according to regulations. Composting is a temporary operation, therefore, cumulative impacts would be limited.

c. Water Quality

Contamination of waterways can occur when livestock deposit waste directly into water, or when leaching and surface runoff transport contaminants to stream, ponds, and lakes (Krueger et al., 2002). Livestock operations that are not properly managed can accelerate erosion and sediment transport to water, alter stream flow, and disrupt aquatic habitats (Krueger et al., 2002). Any such impacts must be considered in conjunction with potential impacts from the proposed action.

(I) No Action Alternative

Under the no action alternative, there is the potential for cumulative impacts to water quality to be significant when added to various impacts due to CAFOs, routine carcass disposal, and/or other actions that have been taken on the site of the mass animal health emergency. Unlined burial and/or open-air burning during a mass animal health emergency must take into account actions that have taken place or will take place on the site, and either mitigates the carcass management actions to decrease potential cumulative impacts so they are not significant or move carcass management activities offsite.

(ii) Standard Action Alternative

The potential for cumulative impacts to water quality under the standard procedures alternative are expected to be minimal. As per the discussion throughout chapter 4, unlined burial and open-air burning have the potential to contribute more environmental impacts than offsite rendering, landfill, and fixed-facility incineration. Offsite facilities take into consideration previous and current disposal activities, and deny the acceptance of carcasses that cannot be adequately processed according to regulations. Composting is onsite and not at regulated facilities, therefore proper mitigations must be used to ensure minimal cumulative impacts to water quality.

2. Human and Wildlife Health

Impacts to the environmental quality have the potential to impact humans and wildlife in the area. Because the potential for significant cumulative impacts to the environment is greater under the no action alternative than under the standard procedure alternative, the potential for cumulative impacts to human health and wildlife are also expected to be greater under the no action alternative. Any impact to soil, air, or water quality has the potential to impact the health of surrounding humans and wildlife. Potential cumulative impacts by regulated carcass management activities, (e.g., rendering, fixed-facility incineration, and landfill) are expected to be negligible. Composting is onsite and not at regulated facilities, so proper mitigations must be used to ensure minimal cumulative impacts to human and wildlife health.

3. Resources

The supply of resources must be considered and taken into account when determining which carcass management alternative to use during a mass animal health emergency. Depending on the routine carcass management actions, fuel supply, equipment, local expertise, and/or labor may already be limited. In addition, the cause of the emergency may have an impact on the resources that are available to deal with carcass management. For example, during an emergency where human lives are at stake, allotting resources for managing carcasses could become secondary. In these instances, methods that require less resources may be selected over other options.

4. Land Use

Current routine carcass management practices may have already changed or may be in the process of changing how land is used. For example, land typically used for grazing may now be used for unlined burial or open-air burning of routine carcasses. These changes, compounded by any future land use changes resulting from mass carcass management, must be taken into consideration.

5. Disinfection

Routine disinfection may already occur at the site of carcass management activities. Which disinfectants are being used, as well the amount of disinfectant that is used, should be taken into account when dealing with mass animal health emergencies; this would ensure that workers and the surrounding environment are not impacted by the cumulative use of disinfectants.

P. Other Environmental Review Requirements and Considerations

1. Irreversible and Irretrievable Commitments of Resources

When a proposal for a Federal action may significantly affect the quality of the human environment, section 102(2)(C)(v) of NEPA requires Federal agencies to consider any "irreversible and irretrievable commitments of resources" inherent in the implementation of the proposed action. While NEPA does not specifically define these terms, irreversible and irretrievable commitments cannot be changed once made (RD, 2011). For the purposes of this document, irreversible and irretrievable resource commitments are related to effects from the use or destruction of nonrenewable resources or the degradation of resources that cannot be replaced within a reasonable timeframe. Resources potentially affected by carcass management include, but are not limited to, farmland, soil, water, air, plants, wildlife, and historic sites. Resource commitment occurs after site-specific actions are authorized.

Unlined burial and open-air burning disposal options have the potential to cause irreversible or irretrievable commitments, (e.g., to soil and/or air quality) if the proper mitigations are not used. When mitigations associated with the two disposal options cannot be followed, disposal options in the other alternatives should be used to avoid making irreversible or irretrievable commitments.

Rendering, landfill, and fixed-facility incineration activities occur at pre-established facilities. Onsite farmland, soil, water, plants, wildlife, and historic sites would not be impacted when choosing the disposal options in the standard procedures alternative. Properly conducted composting should not impact soil or water quality. Proper management of leachate, gases, particulates, and other wastes will avoid irreversible or irretrievable commitments of resources in those disposal options under the standard procedures alternative.

2. Farmland Protection Policy Act

Under the Farmland Protection Policy Act (FPPA), USDA must consider ways to minimize the unnecessary and irreversible conversion of farmland to nonagricultural uses (7 U.S.C. 4202 (a)). The Federal Government must identify the amount of farmland converted by Federal programs; identify and take into account the adverse effects of Federal programs on the preservation of farmland; consider alternative actions, as appropriate, that could lessen such adverse effects; and assure that Federal programs, to the extent practicable, are compatible with State, unit of local government, and private programs and policies to protect farmland (7 U.S.C. 4201(b)). Guidelines for doing so have been established by USDA, in cooperation with other Federal agencies, and can be found at 7 CFR part 658. An agency may determine on its own whether a site is farmland, as defined by 7 CFR part 658.2(a), or it may request that USDA Natural Resources Conservation Service (NRCS) make the determination.

At the site-specific level, carcass management activities should be designed to prevent irreversible farmland conversion or minimize the amount of farmland that may be affected. Emergency responders must document any identification of farmland that may be affected by carcass management, as well their efforts to avoid irreversible conversion.

APHIS anticipates that open-air burning and composting will convert farmland to nonagricultural use, however, for a limited time. If properly managed, these methods should not cause irreversible conversion of the land. Rendering, landfill, and fixed-facility incineration occur offsite at pre-established facilities so that individual parcels of farmland would not be impacted. Proper management of leachate, gases, particulates, and other wastes will avoid irreversible conversion of farmland to nonagricultural uses.

APHIS anticipates that unlined burial from a mass animal health emergency may result in irreversible conversion of farmland to nonagricultural use. At the time of deciding which carcass management options will be used in a mass animal health emergency, APHIS must consider the potential for irreversible conversion of farmland.

3. Executive Orders 11988 and 11990: Floodplain Management and Protection of Wetlands

EO 11988, "Floodplain Management," requires that Federal agencies avoid adverse impacts associated with occupying or modifying flood plains and avoid supporting floodplain development when there are other practical alternatives. The EO states that "Each agency shall provide leadership and shall take action to … minimize the impact of floods on human safety, health, and welfare…" In addition, "…each agency has a responsibility to evaluate the potential effects of any actions it may take in a floodplain…and to prescribe procedures to implement the policies and requirements of this Order…". EO 11990, "Protection of Wetlands," indicates that "each agency shall…take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for…conducting Federal activities and programs affecting land use…"

Offsite management of carcasses would be occurring in pre-existing facilities, and any use of these facilities for carcass management is not expected to increase impacts to floodplains or wetlands. Onsite management options could take place in or near floodplains or wetlands. In general, it is best if management sites in or near floodplains or wetlands are avoided.

APHIS recommends that carcass burial sites avoid flood plains (APHIS, 2005). Numerous States have regulations or recommendations that require or recommend that carcasses be buried or composted away from floodplains and wetlands. (See table 4–5 for examples.)

Table 4–5. State Regulations/Recommendations for Carcass Disposal In/Near Floodplains and Wetlands.

State	Floodplain	Wetlands
	Location of Burial Pit	
Maine	Not within the 10-year floodplain (MDAFRR, 2012)	Not within 100ft of wetlands of significance (MDAFRR, 2012)
Oklahoma	Not be located closer than one foot vertically above the floodplain (ODAFF, 2011)	—
South Dakota	Not within the boundaries of a floodplain (South Dakota Animal Industry Board, 2011)	Not within a wetland (South Dakota Animal Industry Board, 2011)
	Location of Compost Pile	
Colorado	Outside the 100 year floodplain (Colorado State University, 2006)	Outside wetlands (Colorado State University, 2006)
Georgia	Out of floodplain (Ritz, C.W., 2014)	—
Iowa	Outside of 100 year floodplain (Iowa State University, 2013)	Outside of wetland (Iowa State University, 2013)

Regulations and recommendations for burial or composting carcasses in or near floodplains and wetlands should be followed. Any site-specific EA will need to address mitigations to protect floodplains or wetlands, should they be located within the vicinity of the carcass management site.

Q. Summary of Potential Impacts from Each Alternative

Table 4–6 summarizes the primary potential environmental impacts for issues that have been analyzed in chapter 4. The table is designed to easily compare the analyses within this chapter.

Table 4–6. Summary of Potential Primary Environmental Impacts

Topic	Alternative 1: No Action	Alternative 2: Standard Procedures
Soil Quality		
Compaction, erosion, and disturbance	Impacts	Impacts at preexisting facilities not expected. Compaction and disturbance may occur with composting.
Pollutants (biological, chemical, radiological agents)	Impacts from uncontrolled releases	Potential impacts can be mitigated to a greater extent and are less likely than for the No Action.
Air Quality		
Odors	Impacts from uncontrolled releases	Potential impacts can be mitigated to a greater extent and are less likely than for the No Action.
Pollutants (biological, chemical, and radiological)	Impacts from uncontrolled releases	Potential impacts can be mitigated to a greater extent and are less likely than for the No Action.
Water Quality		
Pollutants (biological, chemical, and radiological agents)	Impacts from uncontrolled releases	Potential impacts can be mitigated to a greater extent and are less likely than for the No Action.
Vegetation		
Removal, compaction, and/or burning	Impacts	Potential impacts by regulated preexisting facilities are unlikely. Composting impacts less than No Action. Compaction will occur.
Plant nutrient availability	Impacts	Potential impacts by regulated preexisting facilities are unlikely. Composting may cause localized increase.
Invasive plant species	Potential for creating suitable habitats for invasives	Potential impacts less likely than for No Action.
Human Health and Safety		
Pollutants (biological, chemical, radiological agents)	Potential impacts to workers minimized through the use of personal protective equipment Potential impacts to public, yet some impacts can be minimized through biosecurity systems	Potential impacts to workers are less than in No Action. Potential impacts to public minimized through containment systems, especially during transportation

Table 4–6, continued.

Noise, odors, and aesthetics	Potential impacts	Potential impacts can be better mitigated than in No Action.
Environmental Justice (EJ)	Potential impacts dependent on distance between the EJ community and the carcass management sites	Generally less impacts than the No Action. EJ issues at fixed-facility sites should have been already addressed during siting, construction, and determining the range of permitted activities
Cultural and historic resources; tribal resources	Minimal impacts	Impacts not expected
Disinfectants	Potential for impacts to workers, although mitigated through personal protective equipment.	Potential impacts same as for No Action.
Transportation	Limited potential impacts	Potential impacts same as No Action, as long as proper mitigations are in place.
Livestock and Domestic Animals		
Pathogens and chemicals through soil, water, air, and scavenging	Potential impacts from uncontrolled release of organisms and chemicals	Potential impacts reduced because releases are avoided or decreased to acceptable levels
Wildlife		
Pathogens and chemicals through soil, water, air, and scavenging	Potential impacts from uncontrolled release of organisms and chemicals	Potential for impacts are less than in No Action.
Endangered species, bald and golden eagles, and migratory birds	Potential impacts from uncontrolled release of organisms and chemicals	Potential for impacts are less than in No Action.
Climate Change		
Climate change impact on carcass management	Potential for increased number of emergencies	Potential impacts same as in No Action
Carcass management impact on climate change	Temporarily reduction in GHG emissions due to mass mortality likely offset by emissions due to carcass management	Technology-based GHG emission captured or avoided
Cumulative Impacts		
Impacts to soil, air, water quality	Potential for impacts	Potential for impacts are less than in No Action.
Human and animal health	Potential for impacts	Potential for impacts are less than in No Action.

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Appendix A. Pertinent State Laws Regarding Carcass Management

During an animal health emergency, the lead Federal agency and State officials cooperatively develop carcass management options from the measures identified by statutes and rules, and may rely on these authorities to implement necessary disposal measures. Additional city and county ordinances and local health laws also are considered at that time. Table A–1 presents information demonstrating the range of State agencies and entities with authority to act in mass animal health emergencies. The listed legal references define the entities and identify who can create rules and establish quarantines.

Carcass Management Time: Many States require livestock carcass management within a short interval of death or discovery of the carcass. The discovery of a carcass presents a distinct issue when livestock are found dead from unknown causes. In the State of Washington, any livestock found dead from an unknown cause is presumed to have died because of disease (Wash. Rev. Code § 16.32.102), and disposal options are consequently restricted (Wash. Rev. Code § 16.36.102). North Dakota also presumes found carcasses, ". . . died from a contagious or infectious disease" (N.D. Cent. Code § 36-14-19).

An example of a practical approach toward storage occurs in Maine where, "Carcasses may be stored only long enough to arrange proper disposal. If ambient air temperatures are above freezing and storage must be for more than 24 hours, the responsible party shall seek guidance . . . on issues such as leachate and vector control. . ." (Code Me. R. § 01-001-211). Maine also created an Animal Response Team to facilitate prompt, coordinated, and effective responses to animal disasters (7 Me. Rev. Stat. §§ 1901, 1902).

Unlined Burial: In general, comparisons among the States regarding burial depth appear to reflect prevailing soil porosity and weather. Setback requirements vary and some States provide limitations on the total weight of carcasses that can be buried at a site in a given time interval. States generally allow burial of livestock on the land or property of the owner with appropriate setbacks, but in a mass animal health emergency, this may not be practical or possible because the volume of material to be disposed of may exceed the capacity of the site.

Open-Air Burning: States explicitly ban open-air burning or may require approvals prior to burning. For example, Illinois and Montana ban open-air burning (Ill. Admin. Code title 8, § 90.110 and Mont. Admin. R. 17.8.604(1)(h)) while Idaho and Kansas require permits (IDAPA § 02.04.17.030(09) and Kan. Admin. Regs. 28-19-645, 28-19-647(b)). Yet, on at least one occasion, it appears EPA allowed an amendment to a State air quality plan to include open-air burning of diseased animal carcasses to prevent a public health emergency (40 FR 300.310(c); 40 CFR § 52.320(c)(115)).

Rendering and Fixed-Facility Incineration: Rendering and incineration regulations generally dovetail with requirements for the carcass hauling and meat inspection industries to ensure food safety.

Landfill: States may explicitly authorize landfill disposal or allow landfill disposal during emergencies. For example, disposal in Alaska and Missouri is allowed in permitted sanitary landfills (18 Alaska Admin. Code § 60.010(d)(2)(A); Mo. Rev. Stat. § 269.020(8)), and California's rules allow licensed haulers to transport carcasses to appropriately permitted landfills during an emergency (CA Food & Agric. Code § 19348).

State law can define carcasses as agricultural solid waste, food waste (garbage), infectious waste, or any type of hazardous waste which allows burial within regulated landfills. For example, Louisiana defines carcasses as garbage (La. Admin. Code 7: 101 (2013). Nevada considers "solid waste" to include all putrescible and nonputrescible refuse in solid or semisolid form including carcasses (Nev. Rev. Stat. § 444.490). Conversely, Connecticut defines "infectious waste" as, "Any discarded animal carcass, animal body part or animal bedding, when such carcass, part or bedding is known to be contaminated with or to have been exposed to an infectious agent" (Conn. Agencies Regs. § 22a-209-15(a)). "Biomedical waste" means untreated solid waste . . . which has not been decontaminated . . . including infectious waste" (Conn. Agencies Regs. § 22a-209-15(a)). Infectious waste may be disposed of by . . . other equivalent method providing protection of the public health and environment as described (Conn. Agencies Regs. § 22a-209-15(f)(C)). This contrasts with States recognizing regulated "medical wastes" as encompassing contaminated carcasses only when intentionally infected as part of research activities (e.g., Tenn. Comp. R. & Regs. R0400-11-01-.01(2)), which may even be limited only to carcasses exposed to agents infectious to humans (NJ Admin. Code title 7 § 26-3A.6).

The finite capacity of existing landfills coupled with increasing transportation costs associated with disposed materials is a politically sensitive issue (Palmer, 2011; Thornley, 2009). In the context of emergency carcass management, a large volume of carcasses would occupy an even greater landfill volume than most material regularly disposed of because of the large amounts of soil and cover materials needed to properly bury these carcasses (Haskell and Ormond, 2003; Nutsch and Spire, 2004), and the time needed for them to degrade (Kim and Kim, 2012; Yuan et al., 2013). States recognize this dynamic situation and, consequently, State laws keep landfill disposal as one option for carcass management.

Table A–1. State Information Pertinent to Animal Health Emergency.*

State/Territory	Authority to Set Quarantines, Coordinate Emergency Responses, and/or Create Rules	Pertinent References
Alabama	AL State Board of Agriculture and Industries; Commissioner and State veterinarian	Alabama Code §§ 2-15-170, 2-15-172, 2-16-21; Ala. Admin. Code Rule 80-3-6-.04
Alaska	AS Department of Environmental Conservation; Commissioner and State veterinarian	Alaska Statute § 03.05.011
Arizona	AZ Department of Agriculture, Animal Services Division; Director with the advice of the State veterinarian	Ariz. Admin. Code 3-1201, 3-1203
Arkansas	AR Livestock and Poultry Commission; a "commission employee" to stop vehicles and quarantine contents (Ark. Code Ann. § 2-33-108); hog cholera (§§ 2-40-706, 2-40-707); for cattle ticks, a quarantine recommendation approved by the commission is submitted to the Governor who makes a proclamation (§ 2-40-1002, 2-40-1003); "an authorized agent" of the AR Livestock and Poultry Commission for equidae quarantines (§ 2-40-812)	Ark. Code Ann. §§ 2-40-103, 2-40-401, 2-40-403, 2-40-404, 2-40-405, 2-40-1302; 2-40-1304
California	CA Department Food and Agriculture; State veterinarian	Cal. Food and Agricultural Code §§ 9141, 9175, 9561, 9562, 9569; 3 CCR 797, 905, 1301, 1302
Colorado	CO Department of Agriculture; Commissioner and State veterinarian	Colo. Revised Statute § 35-42-103, 35-50-105, 35-50-111, 35-53-111
Connecticut	CT Department of Agriculture; Commissioner and assistants as needed, State veterinarian supervises quarantines, plus municipal ordinances for animal disposal	Conn. General Statutes §§ 7-148, 22-26f, 22-278, 22-279, 22-284; Conn. Agencies Regs. § 22-278
Delaware	DE Department of Agriculture; the Department or its authorized agents	Del. Code Ann. Title 3, §§ 7101, 7102, 7104, 7322
Florida	FL Department of Agriculture and Consumer Services Division of Animal Industry, Division of Animal Industry; Governor or Commissioner of Agriculture declares emergency	Fla. Statute Ann. §§ 585.08, 585.145, 585.16, 585.22
Georgia	GA Department of Agriculture, Animal Industry Division; Commissioner of Agriculture, State veterinarian	Ga. Code Ann. §§ 4-1-1, 4-1-3, 4-4-2, 4-4-64, 4-4-67, 4-4-70, 4-4-71, 4-4-83, 4-4-120; Ga. Compiled Rules & Regs. Rule 40-13-4-.02, 40-13-4-.17
Guam	Guam Department of Public Health and Social Services; Executive Order (10 Guam Code Ann. §§ 19401 to 19405 for public health emergency during bioterrorism). Department of Agriculture; Director	5 Guam Code Ann. § 61102; 10 Guam Code Ann. §§ 19104, 19401, 19402, 35105

Table A–1, continued.

State/Territory	Authority to Set Quarantines, Coordinate Emergency Responses, and/or Create Rules	Pertinent References
Hawaii	HI Department of Agriculture, Division of Animal Industry; HI Department of Agriculture, State veterinarian	11 Haw. Revised Statute §§ 142-2, 142-3, 142-6, 142-9; Haw. Admin. Rule § 4-16-5, 4-17-11, 4-20-11, 4-28-12
Idaho	ID State Department of Agriculture, Division of Animal Industries; Administrator, and “any inspector or agent of the USDA APHIS VS”	Id. Code §§ 25-203, 25-218; Idaho Admin. Procedures Act 02.04.17.010, 02.04.17.030
Illinois	IL State Department of Public Health and the IL Department of Agriculture; “the Department”	20 Ill. Compiled Statutes §§ 2305/2(a), (g); 410 Ill. Compiled Statutes §§ 605/1, 605/2.1, 605/2.2
Indiana	IN State Board of Animal Health; State veterinarian	Ind. Code §§ 4-21.5-4, 4-22-2-37.1, 15-17-3-1 to 15-17-3-23, 15-17-10-1, 15-17-10-3, 15-17-10-10
Iowa	Department of Agriculture and Land Stewardship; an officer, regular assistant, or duly authorized agent; State veterinarian	Iowa Code §§ 159.1, 163.1, 165B.2, 167.2; 21 IAC 61.1, 64.1, 64.17, 64.186
Kansas	KS Animal Health Board; KS State livestock commissioner; quarantines by proclamation of governor	Kan. Statute Ann. §§ 47-610, 47-611, 75-1901
Kentucky	KY Board of Agriculture; State veterinarian (as chief executive agent of the board)) or representative of State veterinarian	Ky. Revised Statute Ann. §§ 257.010, 257.230, 257.050, 263.100, 263.010; 302 Ky. Admin. Regs. 20:030, 20:250, 21:00, 21:080
Louisiana	LA Board of Animal Health; Commissioner of Agriculture and Forestry or designee	La. Revised Statute Ann. §§ 3: 1, 2133, 2135
Maine	ME Commissioners of Agriculture, Food and Rural Resources, Conservation and Forestry or designee	7 Me. Revised Statute Ann. § 1751; Code Me. Rule § 01-001-211
Maryland	Department of Agriculture; Secretary of Agriculture presents facts to the Governor who declares quarantine by proclamation	Md. Agriculture Code §§ 2-102, 3-102 to 105
Massachusetts	Department of Food and Agriculture, Division of Animal Health; Director of Animal Health	Mass. General Laws ch. 129 §§ 1 to 3, 28
Michigan	Department of Agriculture; Director or authorized representative	Mich. Compiled Laws § 287.653, 287.708, 287.709, 287.712; Mich. Admin. Code Rule 287.704, 287.652

Table A–1, continued.

State/Territory	Authority to Set Quarantines, Coordinate Emergency Responses, and/or Create Rules	Pertinent References
Minnesota	MN Board of Animal Health; Board certifies the case to the Governor, who declares an emergency; this allows the Board to establish quarantine zones; Board and designated licensed veterinarians issue orders	Minn. Statutes §§ 29.051, 34A.11, 35.05, 35.0661, 35.815; Minn. Rule 1520.0200; Minn. Rule 1721.0020; Minn. Rule 1721.0270
Mississippi	MS Board of Animal Health and Department of Agriculture and Commerce (swine); State veterinarian who may appoint inspectors and range riders, and licensed veterinarians and Board of Supervisors of any County; Governor declares state of emergency when advised by MS Board of Animal Health; also Commissioner of Agriculture and Commerce (swine)	Miss. Code Ann. §§ 19-5-15, 69-11-3, 69-11-9, 69-11-13, 69-15-9, 69-15-13, 69-15-15 (anthrax), 69-15-61, 69-15-101, 69-15-109, 75-40-103, 75-40-111
Missouri	MO Department of Agriculture; Director or designated representative; State veterinarian creates emergency plan with Department of Natural Resources assistance	Mo. Revised Statutes §§ 261.020, 267.240, 267.400, 269.010, 269.021, 269.200
Montana	MT Board of Livestock, Disease Control Bureau, or Department of Livestock; any deputy State veterinarian or authorized quarantine agent; or by proclamation of the Governor	81 Mont. Code Ann. §§ 2-102, 2-103, 2-112, 20-101; Mont. Admin. Rule §§ 32.1.101, 32.3.106, 32.3.108, 32.4.101
Nebraska	Department of Agriculture, Bureau of Animal Industry (rules made in consultation with the Departments of Environmental Quality and Health and Human Services); State veterinarian and Bureau of Animal Industry employees	R.R.S. Neb. § 2-3005; 54 Neb. Revised Statute §§ 701, 701.03, 703, 795; Neb. Admin. Rules & Regs. §§ 23.002.23, 23.002.50, 23.003.11
Nevada	NV State Department of Agriculture; Director (State Quarantine Officer)	571 Nev. Revised Statute §§ 018, 019, 023, 045, 130, 140, 220
New Hampshire	Department of Agriculture, Markets, and Food -- Division of Animal Industry; Commissioner and State veterinarian	436 N.H. Revised Statute Ann. §§ 2, 8, 16, 34, 35; N.H. Code Admin. Rule Ann. Agriculture 103.04
New Jersey	NJ Department of Agriculture; Secretary of Agriculture and/or State Board of Agriculture (as advised by the Director of the Division of Animal Health)	N.J. Statute Ann. §§ 4:1-21.5, 4:5A-20, 24:16B-3, 24:16B-18; N.J. Admin. Code Title 2, §§ 2-1.2, 2-1.3, 5-1.1, 5-4.1
New Mexico	NM Livestock Board; Board (may request the governor to declare an emergency)	77 N.M. Statute Ann. §§ 2-1.1, 2-7, 3-1; N.M. Admin. Code Title 21, §§ 30.2.7, 30.4.7
New York	Department of Agriculture and markets; Commissioner of agriculture and markets and employed veterinarians	NY agriculture & markets §§ 5, 76

Table A–1, continued.

State/Territory	Authority to Set Quarantines, Coordinate Emergency Responses, and/or Create Rules	Pertinent References
North Carolina	Board of Agriculture. For an animal: State veterinarian or authorized representative For an area: State veterinarian consults with the Commissioner of Agriculture and needs Governor approval	N.C. General Statutes §§ 106-121, 106-304, 106-306, 106-307.2, 106-393, 106-401, 106-403
North Dakota	ND State Board of Animal Health; the Board	N.D. Century Code §§ 36-01-00.1, 36-01-12; 48 N.D. Admin. Code §§ 04-01-02, 04-01-06, 04-01-07, 04-01-08
Ohio	OH Department of Agriculture; Director of Agriculture or authorized representative	Ohio Revised Code Ann. §§ 901.19, 941.03, 941.07, 941.15; Ohio Admin. Code § 901:1-21-02
Oklahoma	OK State Board of Agriculture; State veterinarians, President of the Board, or authorized agents issue orders based on State Board of Agriculture or State veterinarians determination, but President issues emergency orders, and State veterinarian establishes quarantine zones upon emergency declaration by the Governor; emergency poultry disposal methods by OK Department of Agriculture, Food, and Forestry	Okla. Statute Title 2,§§ 1-3, 2-4, 6-124, 6-134, 6-402, 6-405, 10-9.7; 35 Okla. Admin. Code § 15-1-2, 15-3-1
Oregon	OR Department of Agriculture OR Department of Environmental Quality (for Feeding or Holding Operations); Director of Agriculture (and for carcass disposal, authorized representatives)	Or. Revised Statutes §§ 561.510, 561.560, 596.392, 596.393; Or. Admin. Rules 603-011-0384, 340-051-0010
Pennsylvania	Department of Agriculture of the Commonwealth of PA; the Department	7 Pa. Code §§ 5.1,5.46, 5.83, 17.1, 17.11
Puerto Rico	Department of Health; Secretary of Health with approval by Council of Secretaries and Secretary of Agriculture of the Commonwealth of Puerto Rico	P.R. Laws Ann. Title 5, §§ 684, 734, 735, 735a
Rhode Island	RI State Department of Environmental Management; State inspectors in cooperation with the USDA or any agent of the State, Director of Environmental Management	R.I. General Laws §§ 4-4-13, 4-4-23
South Carolina	SC State Livestock-Poultry Health Commission; delegated officers or employees of the Commission	S.C. Code Ann. §§ 47-4-20, 47-4-30, 47-4-70
South Dakota	Animal Industry Board; the Board, after consultation with and approval by the Governor	S.D. Codified Laws §§ 40-3-14, 40-5-7, 40-5-8; S.D. Admin. Rule 12:68:03:10
Tennessee	TN Department of Agriculture; Commissioner of Agriculture and State veterinarian	Tenn. Code Ann. §§ 44-2-101, 44-2-102, 44-2-405

Table A–1, continued.

State/Territory	Authority to Set Quarantines, Coordinate Emergency Responses, and/or Create Rules	Pertinent References
Texas	TX Commission on Environmental Quality with the TX Animal Health Commission; Executive Director of the Texas Animal Health Commission	Tex. Agriculture Code Ann. §§ 161.004, 161.041, 161.0415, 161.0416, 161.061; 4 Tex. Admin. Code §§ 45.2, 57.10, 57.11, 58, 59.12
Utah	UT Department of Agriculture and Food; Commissioner with approval of the governor, or the Department of Agriculture and Food or its agents	Utah Code Ann. § 4-31-2; Utah Admin. Code R58-2-3
Vermont	VE Department of Agriculture, Food and Markets; Secretary of Agriculture, Food and Markets, and designees	6 Vt. Statutes §§ 1151, 1157, 1158
Virgin Islands	VI Department of Agriculture; Commissioner of Agriculture creates rules for disposal, and limits importations with the approval of the Governor	19 V.I. Code Ann. §§ 2501, 2602, 2705, 2706, 2709, 2715, 2725
Virginia	VA Board of Agriculture and Consumer Services; State veterinarian or representative, and counties, USDA inspectors empowered	Va. Code Ann. § 3.2-100, 3.2-5900. 3.2-5901, 3.2-6002 to 3.2-6009, 15.2-1200, 3.2-6015; 2 VAC 5-190-10 to 5-190-30, 5-200-20 to 5-200-60
Washington	WA Department of Agriculture; Director of the Department of Agriculture or authorized representative (persons may request a hearing if their animal is quarantined)	Wash. Revised Code §§ 16.36.005, 16.36.010, 16.36.090, 16.36.098
West Virginia	WV Department of Agriculture; WV Commissioner of Agriculture and authorized agents	W. Va. Code §§ 19-2B-2, 19-9-1, 19-9-2, 19-9-7, 19-9-8, 19-9-13, 19-9-15, 19-9-34
Wisconsin	WI Department of Agriculture, Trade and Consumer Protection; authorized agents	Wis. Statutes §§ 93.01, 93.07, 95.17, 95.19, 95.23, 95.31, 95.34, 95.50; Wis. Admin. Code ATCP 10.01, 10.89
Wyoming	Livestock Board; State veterinarian notifies Governor who declares emergency, State veterinarian may deputize Federal inspectors or appoint them as agents	Wyo. Statutes Ann. §§ 11-19-103, 11-18-111

* All statements from statutes, rules, regulations, and bulletins are derived from free, Web-based materials available as of August 2014, and use of the information is at the sole risk of the user. USDA makes no warranty or representation of any kind, expressed or implied. Each State may have more current or accurate information. USDA provides this information on an “as is” basis for comparison purposes only, and it shall not be liable or held responsible for any omissions, additions, or errors.

Admin. = Administrative; Ann. = Annotated; Regs. = Regulations

In any given State, the list of available carcass management options generally includes the measures considered in this EIS. Applicable laws vary, and this section briefly considers State law aspects associated with the most commonly authorized methods: burial, open-air burning / incineration, rendering, and composting. Table A–2 summarizes various information regarding the range of disposal options available in each State and territory. For each option, the listed statute or regulation identifies the authorization, but only some of the conditions, limitations, and special situations are mentioned. Readers should consult current State brochures and factsheets for additional information, as well as note the disclaimers on the tables below.

Table A–2. State Disposal Options.*

State and References	Time Limit	Burial Depth/Setback	Burning: Open-Air	Burning: Fix-fac. Incinerator	Rendering	Landfill	Compost
Alabama (Ala. Code § 2-16-41; Ala. Admin. Code Rule 80-3-6-.26, Rule 80-3-6-.34, 80-3-8-0.11 80-3-20.01; ADEM 335-6-7, 335-13-1)	24 h	4 ft/none but if catastrophic losses 2ft/Yes (poultry in pit)	If State veterinarian approves, but is required for anthrax	Type 4 approved facility	> 220 ^{o}F > 4 hours; sanitary hauling	Sanitary landfills and freezers (USDA-NRCS, 2005)	At composting facilities (USDA-NRCS, 2005)
Alaska (18 Alaska Admin. Code Title 18, § 60.010; Anon., 2011)	—	1ft/100 ft from H_2O SV approval	—	Facility Permit	—	Facility permit	—
Arizona (Ariz. Admin. Code 18-13-311, 18-13-312)	—	Y	—	Y	Y	Y, final 2 ft cover	Y
Arkansas (Ark. Code Ann. §§ 2-40-302, 2-40-403)	—	Y, covered with 1 in lime if anthrax	Y	Y	Y	Barred by § 2-40-1302	Y
California (Ca. Food & Agriculture Code §§ 9141, 9142,19348; Ca. Str. & Hwy. § 91.8 roadkill is disposed under Fish & Game Code Rules; 3 CCR 905)	—	Y if by owner within 3 miles of death site	Y if diseased	Y	Y	Facility permit or with renderer certification in emergencies	—
Colorado (6 Colo. Code Regs. § 1007-2.1.9, 2.1.2, 3.3.4, 14.1, 14.2)	—	6 in cover	Y in extreme emergen-cies	Y	—	—	Y
Connecticut (Conn. General Statute §§ 7-148, 22-324a-1, 22a-209-15)	24 h poultry	Emergency poultry pits setback/water/ depth/cover requirements	—	—	—	As biomedical waste	—
	Municipality control for dead animal disposal ordinances (Conn. General Statute § 7-148).						
Delaware (Del. Code Ann. Title 16, § 1801)	—	—	—	—	—	As solid waste	—
Florida (Fla. Statute Ann. § 823.041)	—	Y, 2 ft depth		Y	Y	—	—
Georgia (Ga. Code Ann. §§ 4-4-43, 4-5-2, 4-5-3, 4-5-5)	24 h	Y, 3 ft depth	Y	Y	Y	Y by arrangement	—
	". . . or any method using appropriate disposal technology which has been approved by the Commissioner of Agriculture" (Ga. Code Ann. § 4-5-5).						
Guam (10 Guam Code Ann. § 35105)	24 h	Y; > 3 ft depth if > 50 lbs. or >1 ft if < 50 lbs.; >300 ft to water	—	—	—	—	—
Hawaii (11 Haw. Revised Statute § 159-36)	—	—	—	—	Y	—	—

Table A–2, continued.

State and References	Time Limits	Burial Depth/Setback	Burning		Renderings	Landfill	Compost
			Open-Air	Fix-fac. Incinerator			
Idaho (Idaho Code §§ 25-227, 25-237, 25-3201; Idaho Admin. Procedures Act 02.04.17.000 et seq.)	72 h; 24h swine	Y	Only if authorized	Y	Y	Sanitary landfill	Y
	Also air curtain incineration, digestion (hydrolysis), natural decomposition (if > 1,320 ft setbacks are met), and the Administrator may grant variances (Idaho Admin. Procedures Act 02.04.17.030). For dead animal emergencies, the Administrator may authorize open burning, pit burning, burning with accelerants, pyre burning, air curtain incineration, mass burial, and natural decomposition, etc. (Idaho Admin. Procedures Act 02.04.17.050).						
Illinois (Ill. Admin. Code Title 8 § 90.110)	—	6 in /200ft from water or houses; up to 3,000 lbs per site every 2 yrs; ≤ 3 sites within 120 ft; lime prohibited	Barred by law	Facility permit	Licensed Renderer	Sanitary landfill	Y; requirements vary with carcass species
Indiana (Ind. Code §§ 15-17-11-20; Indiana State Board of Animal Health Technical Bulletin LG-1.97)	24 h	4 ft deep, also exotic animal feeding, anaerobic and chemical digestion	"Burn piles" deemed insufficient	Y	Approved disposal plant	Y with landfill manager permission	Y
Iowa (Iowa Code §§ 167.12, 167.18; Iowa Admin. Code r. 21—61; but Iowa Admin. Code Rules 8—100.4 special private agency disposal rules)	24 h (burial); or "within a reasonable time after death"	> 4 ft deep; quicklime required	Within 24 h if anthrax or hog cholera	—	Y	—	—
Kansas (Kan. Statute Ann. §§ 47-1211, 14-1219, Supp. 65-1,199; Kan. Admin. Reg. 28-18a-17, 28-19-645 to 647)	—	Y	Prohibited unless authorized by rules	Y	Y	—	Y
	Remains from rendering must be buried within 48 h more than 3 ft deep and covered with quick-lime (Kan. Statute Ann. § 47-1211). For swine, ". . . or other methods as approved by the Kansas Animal Health Department" (Kan. Admin. Reg. 28-18a-17).						
Kentucky (Ky. Revised Statute Ann. §§ 257.160)	48 h unless the carcass is in cold storage	> 4 ft deep, 2 in quicklime; 3 ft cover/ 100 ft setback	—	Y	Y (boil > 2 h)	Y (Ky. Revised Statute ch 224)	Y
	Any combination of methods, and "Any other scientifically proven method of disposal approved by the board." (Ky. Statute Revised § 257.160.)						
Louisiana (La. Revised Statute Ann. §§ 3: 2131; La. Admin. Code 7:707, 7:119, 51:105)	Poultry: without delay	>6 ft deep (>4 ft deep sheep, goats, swine)	—	Y	Y within city or towns under permit	—	Y and digesters for poultry
	". . . or otherwise disposed of in such a manner as not to constitute a nuisance or hazard to the public health" (La. Admin. Code, Title 51 § 105).						

Table A–2, continued.

State and References	Time Limit	Burial Depth/Setback	Burning: Open-Air	Burning: Fix-fac. Incinerator	Rendering	Landfill	Compost
Maine (Code Me. Rule § 01-001-211)	"only long enough to arrange proper disposal"	Y	—	Y	Y	Y	Y
	Gasification / pyrolysis anaerobic digestion, thermal hydrolysis and ". . . other methods as approved by the Commissioner" (Code Me. Rule § 01-001-211), and ". . . non-traditional rendering methods, such as fluidized bed drying, flash dehydration and extrusion" (Code Me. Rule § 01-001-211-12). For FMD, any animal infected with or exposed must be buried, rendered, processed "or otherwise disposed of under the direct supervision of the commissioner or his duly authorized agent" (7 Me. Revised Statute § 1815).						
Maryland (Md. Agriculture Code §§ 3-108, 3-109)	—	> 3 ft	Owners must burn within 3 h before sunset of the day following the discovery of the animal		—	—	—
	". . . owner may dispose of the carcass . . . pursuant to the departmental rules and regulations, and in a manner that does not tend to spread disease or endanger the public health" (Md. Agriculture Code §§ 3-108).						
Massachusetts (Mass. General Laws ch. 129 §§ 11 to 14; Mass. Regs. Code title 330 §§ 25.01 to 25.06, title 310 §§ 19.006, 19.130, 19.061)	—	Y	—	—	—	Y as special (infectious) waste	Y
	" . . . buried or otherwise disposed of." (Mass. General Laws ch. 129 §§ 13A to 14, methods may be as determined by the Director of the Animal Health division).						
Michigan (Mich. Comp. Laws §§ 287.652, 287.656, 287.671, 750.57); Mich. Admin. Code Rule 287.652)	24 h and covered with 1 ft soil; weight limits that can be waived	2.5 ft (or > 4 ft if < 1 mile from a residence)	—	Y	Y	—	Y
Minnesota (Minn. Statute § 35.82; Minn. Rules 1721.0700, 1721.0740)	". . . as soon as reasonably possible. . ." < 72 h	Y ". . . at a depth adequate to prevent scavenging . . ."	Y	Y	Y	—	Y
	". . . another manner approved by the board as being equally effective for the control of animal diseases" (Minn. Rule 1721.0700).						
Mississippi (Miss. Code Ann. §§ 19-5-15, 41-51-5, 41-51-13, 69-15-15)	Immediate-ly	Y for anthrax 6 ft & covered with lime	Y for anthrax	—	Licensed rendering plants	—	—
Missouri (Mo. Revised Statutes §§ 269.020; 269.021)	24 h	Y; > 6 ft, distance, load, & acreage restrictions	—	Y	—	Permitted landfill	Y
	Or ". . . in a manner approved by the State veterinarian . . ."						

Table A–2, continued.

<table>
<tr><th rowspan="2">State and References</th><th rowspan="2">Time Limit</th><th rowspan="2">Burial Depth/Setback</th><th colspan="2">Burning</th><th rowspan="2">Rendering</th><th rowspan="2">Landfill</th><th rowspan="2">Compost</th></tr>
<tr><th>Open-Air</th><th>Fix-fac. Incinerator</th></tr>
<tr><td rowspan="2">Montana (Mont. Code Ann. § 81-2-108; Mont. Admin. Rules §§ 17.8.604, 17.50.503, 32.3.125, 32.4.1002, 32.6.1102)</td><td>—</td><td>Y;
> 4 ft covered with quicklime</td><td>N</td><td>Y</td><td>Y</td><td>—</td><td>—</td></tr>
<tr><td colspan="7">“ . . . in a satisfactory manner . . .” meeting county solid waste requirements and not a public nuisance or menace to livestock (Mont. Admin. Rules §§ 32.3.125; 32.4.1002); for buffalo or bison, “. . . under a plan approved by the governor, use any feasible method . . .” (including bury, incinerate, render, donate, or slaughter) (Mont. Code Ann. § 81-2-120).</td></tr>
<tr><td>Nebraska (Neb. Revised Statutes §§ 54-701, 54-701.03, 54-703; 54-744, 54-744.01, 54-745, 54-776, 54-795; 23 Neb. Admin. Rule & Regs. § 002.50; 17 Neb. Admin. Rules & Regs. §§ 001 to 007)</td><td>36 h</td><td>4 ft / > 500 ft to houses; > 6 ft anthrax</td><td>—</td><td>Y</td><td>Y;
liquefaction barred unless in research</td><td>—</td><td>Y;
Alkaline hydrolysis</td></tr>
<tr><td rowspan="2">Nevada (Nev. Revised Statutes § 571.200; Nev. Admin. Code §§ 444.640, 445B.22067, 445B.2207, 445B.22073, 571.515, 571.555, 584.2831)</td><td>—</td><td>3 ft deep</td><td>Y
if meets § 445B.22067</td><td>Y
if meets § 445B.2207</td><td>—</td><td>Y
but no burning at specific sites</td><td>—</td></tr>
<tr><td colspan="7">Carcasses of dead hoofed mammals, “. . . must be disposed of in a sanitary manner.” (Nev. Admin. Code § 584.2831.)</td></tr>
<tr><td>New Hampshire (N.H. Revised Statutes §§ 427:50, 436:16, 436:17, 436:25, 436:40)</td><td>—</td><td>Covered with lime</td><td>Y</td><td>Y</td><td>Y
but not for certain diseased animals (§§ 436:25, 40)</td><td>—</td><td>—</td></tr>
<tr><td rowspan="2">New Jersey (N.J. Revised Statutes §§ 4:5-11, 24:16B-18; N.J. Admin. Code Title 2, §§ 2-4.21, 2-4.28, 91-3.1, 91-3.5 to 3.9)</td><td>—</td><td>Y
On the premises</td><td>—</td><td>—</td><td>Y
if frozen ground or extreme heat</td><td>—</td><td>Y
after contact with State veterinarian</td></tr>
<tr><td colspan="7">“Dead animals shall be removed immediately and held in rat proof containers until final disposition in accordance with local ordinances.” (N.J. Admin. Code Title 2, § 2-4.2.)</td></tr>
<tr><td rowspan="2">New Mexico (77 N.M. Statute Ann. § 3-4; N.M. Admin. Code Title 20, §§ 2.60.114, 9.2.7, 9.5.9)</td><td>—</td><td>Y</td><td>Y,
as a last option</td><td>Y
if < 5 tons / day in small animal crematoria</td><td>—</td><td>Y
if “infectious waste”; cover immediately when received</td><td>—</td></tr>
<tr><td colspan="7">“. . . or disposed of by the owners as provided by regulations of the board” (77 N.M. Statutes Ann. §3-4).</td></tr>
<tr><td rowspan="2">New York (N.Y. Agriculture & Mkts. 5-C §§ 96-X to 96-Z-12; N.Y. Agriculture & Mkts. § 377)</td><td>72 h</td><td>3 ft deep</td><td>—</td><td>Y</td><td>Y</td><td>—</td><td>—</td></tr>
<tr><td colspan="7">“. . . or otherwise disposed of in a sanitary manner” (N.Y. Agriculture & Mkts. § 377)</td></tr>
</table>

Table A–2, continued.

State and Reference	Time Limit	Burial Depth/Setback	Burning: Open-Air	Burning: Fix-fac. Incinerator	Rendering	Landfill	Compost
North Carolina (N.C. General Statutes §§ 106-403, 106-549.51, 106-549.70; N.C. Admin. Code Title 15A, Rule 02T.0113, Rule18C.121, R.18C.1104)	24 h	3 ft deep/ > 300 ft to water; never in a water system	Y	—	Y	—	Y
North Dakota (N.D. Century Code § 36-14-19; N.D. Admin. Code § 48-04-01-09)	36 h	> 4 ft deep/not along highways or water ways	Y, on site if possible	—	Y; pick up < 24 h after death between May 1st and Nov. 1st.	—	Y
	"... or must be disposed of by a method approved by the State veterinarian." (N.D. Century Code § 36-14-19.)						
Ohio (Ohio Revised Code Ann. §§ 941.14, 953.26, 1511.022)	24 h	> 4 ft deep	Y	—	Y	—	Y
	"... dissolve it by alkaline hydrolysis ... or otherwise dispose of it ..." (Ohio Revised Code Ann. § 941.14). Operators of mink ranches, dog kennels, zoos, captive wildlife farms, and pet food manufacturers may receive raw rendering material with written permission of the Department of Agriculture (Ohio Revised Code Ann. § 953.26).						
Oklahoma (Okla. Statutes Title 2 §§ 6-405, 6-504, 10-9.7, 20-48; Title 35 §§ 15-34-10, 17-3-17, 17-4-17, 19-9)	—	Y, as a last option and if plan protects waters of the State	—	Y for swine if feed oper. has air quality permit	Y	Y	Y
	Each licensed concentrated animal feeding operation develops carcass disposal plans that are approved by the Department of Agriculture (Okla. Statute title 2, § 20-48). Feral swine methods include rendering, landfill, burial, incineration, and composting but all areas must be more than 30 ft from any live swine (Okla. Admin. Code Title 35, § 15-34-10).						
Oregon (Or. Revised Statutes §§ 601.030, 601.140; Or. Admin. Rules 635-044-0255)	—	Y	Y	Y	Y	—	—
	Owners cannot leave carcasses within 0.5 mi of a dwelling or 0.25 mi of water for longer than 15 hours without burying or burning it (Or. Revised Statute § 601.140). Dead wildlife can be burned, incinerated, used as food for other rehabilitated wildlife or retained for educational purposes; approval needed for rendering (Or. Admin. Rules 635-044-0255).						
Pennsylvania (Pa. Cons. Statute §§ 2352, 2353, 2388; 25 Pa. Code § 243.11; 58 Pa. Code § 147.726)	48 h	2 ft deep / >100 ft from waters; must meet water quality regulations	Must meet air quality regulations	Y (wildlife)	Y	Y (wildlife)	Y; also fermenting
	"... burial or incineration or some other sanitary method ... In all cases of death from communicable disease the carcass shall be thoroughly enveloped in unslaked lime" (25 Pa. Code § 243.11). Governmental entities exempt from hauling, disposal, and garbage feeding license requirements (Pa. Cons. Statute § 2388).						
Puerto Rico (P.R. Laws Ann. Title 5 §§ 666, 732)	—	Y; covered with quicklime & > 4 ft deep	—	Y	—	—	—
Rhode Island (R.I. General Laws § 4-4-3)	"... in any manner as not to be detrimental to the public health."						

Table A–2, continued.

State and References	Time Limit	Burial Depth/Setback	Burning		Rendering	Landfill	Compost
			Open-Air	Fix-fac. Incinerator			
South Carolina (S.C. Code Ann. §§ 44-96-190, 44-96-380; S.C. Code of Regulations 61-100.130, 61-107.258, 61-107.4, 61-200.130)	Pits must be approved by department	Y for emergency conditions; 6 in daily cover then capped 2 ft and grassed	—	Y	—	Y	Y
	Swine disposal (S.C. Code of Regulations 61-100.130) regulated separately from other animals (61-200.130).						
South Dakota (S.D. Codified Laws §§ 40-5-15, 40-5-16; S.D. Admin. Rules 12:68:03:05)	36 h	4 ft deep	Y	—	Y	—	—
		if died from non-communicable causes					
Tennessee (Tenn. Comp. Rules & Regs. title 80, ch. 0400-11-01-.04)	48 h	2 ft with 5 ft additional cover; 3 ft if no other cover	—	—	—	Y	—
Texas (Tex. Agriculture Code §§ 161.004, 161.041; 4 Tex. Admin. Code § 59.12)	—	Y, > 3 ft / setbacks as applicable for public health	Y for anthrax and emergen-cies	Y for approved facility or mobile air-curtain incinerator	Licensed and approved facilities	Y by arrangement with officials	Y
	Natural decomposition is allowed if death is not from disease and the location meets all legal requirements; composting and digestion are as approved by the Executive Director; variances from requirements granted on a case-by-case basis (4 Tex. Admin. Code § 59.12).						
Utah (Utah Code Ann. §§ 4-26-1, 4-31-12)	48 h; 24 h hog cholera	Y	—	—	—	—	—
Vermont (Vt. Statute Ann. Title 6, §§ 1159, 3131, 3811)	—	Y; <5 animals in approved pits	—	For rabies	—	Y at certified facilities	—
	For fewer than five farm animals, or a one-time event of greater than five animals, ". . . other solid waste treatment processes, as approved by the Secretary" (Vermont, 2001).						
Virgin Islands (19 V.I. Rules & Regs. § 1560-307)	24 h	Y	—	—	—	—	—
	". . . or other method approved by the Commissioner of Health" (19 V.I. Rules & Regs. § 1560-307)						
Virginia (Va. Code Ann. §§ 3.2-6002, 3.2-6025 to 6029 poultry, 2.1-796.121 companion animals; 2 Va. Admin. Code 5-110-90, 5-200-20 to 5-200-60)	24 h if unrefrig-erated	Y; disposal pit for poultry	—	Y; poultry	Y; poultry	Y; poultry	Y; poultry
	"a method other than as provided . . . if . . . the alternative method meets standards for disposal of dead poultry" (Va. Code Ann. § 3.2-6028) ". . . or other methods acceptable to the Department of Health" (2VAC5-110-90)						
Washington (Wash. Revised Code §§ 16.68.120, 16.36.102)	48 h	Y; also allows "natural decomposition"	—	Y	Y	Y; some solid waste exemptions	Y
West Virginia (W. Va. Code § 19-9-34)	24 h	2 ft /100 ft cover with 3 in lime	—	Licensed facility	Licensed facility	Licensed facility	Y

Table A–2, continued.

State and References	Time Limit	Burial Depth/Setback	Burning		Rendering	Landfill	Compost
			Open-Air	Fix-fac. Incinerator			
Wisconsin (Wis. Statutes §§ 95.34, 95.50, 95.72)	24 h Apr-Nov; 48 h Dec-Mar	Covered with lime	—	—	Y	—	—
Wyoming (Wyo. Statutes Ann. §§ 35-10-104, 11-23-301)	48 h	2ft / 0.5 mile	—	—	Y	—	—

* All statements from statutes, rules, regulations, and bulletins are derived from free, Web-based materials available as of August 2014, and use of the information is at the sole risk of the user. USDA makes no warranty or representation of any kind, expressed or implied. Each State may have more current or accurate information. USDA provides this information on an "as is" basis for comparison purposes only, and it shall not be liable or held responsible for any omissions, additions, or errors.

Abbreviations and special uses of symbols: Admin. = Administrative; Ann. = Annotated; ft = feet; h = hour; in- inch; N = No; Regs. = Regulations; Y = Yes; — = no explicit information found.

Note: If the type of burning was not specified in supporting text, then open-air burning was assumed.

Adaptive Management Alternative (Preferred Alternative): Some States provide the ability to utilize nonstandard management options in a manner similar to the adaptive management alternative. For example, Connecticut indicates disposal options must include protection of public health and the environment at least to the level provided by current disposal methods. Montana indicates that disposal options must be conducted in a satisfactory manner so there is no public nuisance or menace to livestock. Table A–3 provides examples of State language that may include nonstandard disposal options available for use on the adaptive management alternative.

Disposal methods such as natural decomposition do not appear to be frequently mentioned in State laws. Natural decomposition during an emergency is provided for in California, Idaho, and Texas regulations (Cal. Sts. & High. § 91.8(c)(2); IDAPA 02.04.17. 050.02(g); 4 Tex. Admin. Code § 59.12(f)(2)(G)).). Maine identifies a wide variety of disposal methods including gasification, pyrolysis, anaerobic digestion, and thermal hydrolysis. Maine then allows for a variety of methods to be used when approved by the Commissioner (Code Me. R. § 01-001-211).

Table A–3. Examples of States and Territories with Adaptive Management Language for Carcass Disposal in Their Statutes, Regulations, or Rules.*

State	Circumstance and applicable text	Source
Alabama	For poultry, "Any other recommended methods and equipment for the disposal of dead poultry carcasses as may be approved by the State Veterinarian may be used . . . provided such grower obtains written approval for such use from the State Veterinarian."	Code of Ala. § 80-3-20.01
Arkansas	"All other methods and procedures found acceptable . . ." by the Arkansas Livestock and Poultry Commission	Ark. Code Ann. § 2-40-1304
California	For carcasses on state highways, "If disposal technologies including, but not limited to, natural decomposition, burial, incineration, donation, rendering, or composting are not available or practicable, the department may use any nontraditional or novel technology that may be appropriate under the circumstances."	Cal. Sts. & High. Code § 91.8
Connecticut	Infectious animal carcasses disposed of as biomedical waste shall be disposed of by "any other method which provides protection of the public health and environment at least equivalent to that provided by the disposal methods specified in this subparagraph . . . and approved in writing by the Commissioner."	Conn. General Statute § 22a-209-15
Georgia	". . . or any method using appropriate disposal technology which has been approved by the Commissioner of Agriculture"	Ga. Code Ann. § 4-5-5
Kansas	For swine, ". . . or other methods as approved by the Kansas animal health department."	Kan. Admin. Regs. 28-18a-17
Maine	"other methods approved by the Commissioner"	Code Me. Rule § 01 001 211
Minnesota	For mink, ". . . by another method approved by the board as being effective for the protection of public health and the control of livestock diseases."	Minn. Statute § 35.82
Montana	For animals that did not die of anthrax disposed of, ". . . in a satisfactory manner so as not to become a public nuisance or a menace to livestock or poultry." and ". . . in a satisfactory manner that meets the residential county solid waste disposal requirements."	Mont. Admin. Rule 32.3.125 Mont. Admin. Rule 32.4.1002
Oklahoma	For composting swine, "The Department may require another method of carcass disposal other than composting if the Department determines that a more feasible and effective method of carcass disposal exists."	Okla. Statutes title 35, § 17-3-17
Pennsylvania	". . . only in accordance with one of the following methods or a method hereafter approved by the department . . . rendering, fermenting, composting or other method according to procedures and product safety standards established by the department."	3 Pa. Cons. Statutes Ann. § 2352
Vermont	". . . in accordance with approved methods as specified by rule." referring to Vermont Rules and Regulations: Solid Waste Management Procedures: Procedure Addressing Disposal of Dead Animals which includes, "Other Methods: Other solid waste treatment processes as approved by the Secretary"	Vt. Statute Ann. title 6, § 1159
Virgin Islands	". . . shall be disposed of in accordance with regulations prescribed by the Commissioner of Agriculture." and ". . . burial or other method approved by the Commissioner of Health."	V.I. Code Ann. title 19, § 2705; V.I. Rule & Regs. title 19 § 1560-307
Virginia	". . . burial, incineration, or other methods acceptable to the Department of Health."	2 Va. Admin. Code 5-110-90
West Virginia	". . . such other method as the Commissioner may prescribe."	W. Va. Code § 19-9-34

* All statements from statutes, rules, regulations, and bulletins are derived from free, Web-based materials available as of August 2014, and use of the information is at the sole risk of the user. USDA makes no warranty or representation of any kind, expressed or implied. Each State may have more current or accurate information. USDA provides this information on an "as is" basis for comparison purposes only, and it shall not be liable or held responsible for any omissions, additions, or errors.

Appendix B. Pertinent Regulations Regarding Livestock Carcass Transportation

For mass carcass management, APHIS must consider the impacts associated with any program-specific activities. Individuals involved in transporting the carcasses, “must be made aware of the regulations regarding public health, transportation, agriculture, and the environment of those jurisdictions along the selected trade route” (Pullen, 2004).

State Regulations: Routine intrastate transportation of carcasses is a well-regulated industry. Most States and many localities have their own standards and regulations governing the transportation of livestock carcasses which carcass management activities, during a mass animal health emergency, must take into account. Many States require haulers to have a State license or permit (e.g., California, Florida, Georgia, Kansas, Kentucky, Louisiana, Minnesota, and Nebraska). In Mississippi, haulers need to be registered; in New Jersey, a hauler cannot drive onto a premise without first obtaining permission of the property owner. States may limit haulers with restrictions on whether they can haul diseased carcasses, and their destination. For example, haulers must travel directly to their destination in Idaho, Illinois, and Indiana. In Maine and Alabama, diseased carcasses can be transported from the farm (from where they originated, or a quarantined area) only with the permission of the Commissioner or State veterinarian.

Containment is one of the most important factors in transporting carcasses because the physical condition of the carcasses determines how the animals must be transported, and influences the type of vehicle needed. The potential for pathogenic organisms to become dispersed during movement of carcasses may require vehicles to be equipped with specific types of collection or filtration systems. Even without the presence of a disease directly communicable to humans, many States set requirements for transportation vehicles. For example, vehicles must be constructed and maintained so liquid and fluids cannot drip or seep during transport, in essence using a sealed vehicle that prevents seepage or residue from escaping (Florida, Idaho, Indiana, Kansas, and Minnesota). In Arkansas, the statutory language says, “Large animal carcasses may be submitted to a rendering facility in a sealed vehicle that does not allow drainage while being moved.” There may be a requirement to cover or conceal carcasses from public view during transportation (e.g., Idaho, Indiana, Louisiana, and Nebraska,), particularly by use of tarps or other materials (e.g., Arkansas, Illinois, Iowa, Kentucky, Louisiana, and New Jersey). In Alaska, there is a broad requirement to “keep the waste contained”.[Alaska Admin. Code title 18, § 60.015; Ark. Code Ann. §§ 2-33-101, 19-6-448; Fla. Statutes Ann. § 585.147; IDAPA 02.04.17.040.01, 02.04.17.040.02; Ill. Admin. Code title 8 § 90.105; Ind. Code § 15-17-11-17; Iowa Code §§ 167.15; Kan. Statutes Ann. §§ 47-1209; Ky. Revised Statute Ann. § 263.120; La. Admin. Code title 7, § 119; Minn. Statute § 35.82; Neb. Revised Statute § 54-744; N.J. Statute Ann. § 4:5A-24; and N.J. Admin. Code title 2, §§ 2-4.28.]

After transporting the carcasses, many States require vehicles to be disinfested, cleaned, and/or sterilized prior to reuse (e.g., Kansas, Kentucky, and New Jersey). In Alabama and Georgia, the vehicles must be “maintained in a sanitary condition.” The requirement in Maine is for containers to minimize odors and leachate, as well as access by pests.[Ala. Admin. Code; Ga. Code Ann. § 4-4-45; IDAPA 02.04.17.040.04; Ind. Code § 15-17-11-18; Kan. Statutes Ann. §§

47-1209; Ky. Revised Statute Ann. § 263.130; La. Admin. Code Title 7, § 119; Code Me. Rule § 01-001-211-12; and N.J. Admin. Code Title 2, §§ 2-4.29, 5-4.2, 91-3.1.]

While the handling of routine mortalities is well regulated, there has been relatively little planning regarding the transport of animal carcasses in an animal health emergency. "There may be significant health risks, stress variables, manpower issues, and emotional trauma associated with the handling and transportation of diseased animals in an emergency situation" (Pullen, 2004).

Transportation equipment operators, supervisors, and drivers must have the necessary guidance and training when using necessary personal protective gear, handling diseased animals/carcasses, required to obtain necessary permits and other transportation documents, and even able to respond appropriately to the media or other public sources (Pullen, 2004). Workers must be aware that various public health, transportation, agriculture, and environmental regulations create a myriad of requirements as they travel through multiple cities, counties, and States.

<u>Federal Regulations</u>: Federal regulations affecting carcass management transportation may come from USDA agencies, as well as the U.S. Department of Transportation (DOT), U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Federal Emergency Management Agency, and the Occupational Health and Safety Administration, among others. For example, carcass management activities will be required to isolate and track biomass shipments along a transportation corridor. DOT oversees the transportation of hazardous materials under the requirements of the Hazardous Materials Transportation Act of 1975 (HMTA). Biohazard material or biological agents, substance, or materials that can cause injury to animals, humans, or the environment is covered under the HMTA, with specific requirements for their transportation (codified at 49 CFR 172–177). Under these requirements, carcass management activities must isolate and track biomass shipments along a transportation corridor. For instance, infectious substances must carry 6.2 as the label code, the technical name must not be on the outer package, and the quantity cannot exceed 4 kg (49 CFR §§ 172.101, 172.301, 173.27, 175.75). The HMTA also requires DOT-approved methods be used to train employees, to contain and label materials before transport, to clean and disinfect vehicles and equipment, and to trace shipments from the point of origin to final destination (Navarro, undated).

DOT provides some online guidance for transporting diseased animals and infectious and non-infectious materials. For example, "Live animals may not be used to transport infectious substances unless such substances cannot be sent by any other means. An animal containing or contaminated with an infectious substance must be transported under terms and conditions approved by the Associate Administrator for Hazardous Materials Safety" (Healthcare Environmental Resource Center, n.d.). (See the following Web site for more information: http://www.hercenter.org/regsandstandards/dot.cfm. The Web site also directs readers to a tool for checking State guidelines and regulations, which can differ from the Federal; it is located at http://www.hercenter.org/rmw/rmwlocator.cfm.)

Appendix C. Additional Greenhouse Gas Emission Considerations

In February 2010, the Council on Environmental Quality (CEQ) provided guidelines on the mandatory inclusion of assessment of climate change impacts by all proposed projects within Federal agencies (CEQ, 2010). In January 2015, the CEQ provided to agencies for comment the revised set of guidelines that was published for public comment in December, 2014; discussion included a more flexible threshold level for analysis of greenhouse gas emissions and special considerations for the treatment of biogenic sources of GHGs (CEQ, 2014). These guidelines suggest using 25,000 metric tons of carbon dioxide equivalents (mt CO_2 Eq. or 0.025 Tg CO_2 Eq.) as a reference point for agency consideration.

In 2012, 8.1 percent of total U.S. GHGs, or 526.3 teragrams of carbon dioxide equivalents (Tg CO_2 Eq.), primarily in the forms of methane and nitrous oxide gases, was attributed to the agricultural sector. Agriculturally produced non-carbon dioxide emissions of GHG arise from enteric fermentation in domestic livestock, livestock manure management, and agricultural soil management. The aerobic process that microbes use to oxidize ammonium to nitrate is called nitrification, while the anaerobic reduction of nitrate to nitrogen gas is denitrification. During these processes, nitrous oxide is a gaseous intermediate that can become released into the atmosphere. As products move through the nitrogen cycle, there is the potential for additional GHG emissions to occur. The treatment, storage, and transportation of livestock manure produces methane and nitrous oxide from anaerobic decomposition processes, and through the nitrification of dung and denitrification of urine. Indirect nitrous oxide emissions result from the volatilization of nitrogen in manure and the subsequent deposition of these gases and their products onto soils and the surface of lakes and other waters. Indirect nitrous oxide emissions also result from the runoff and leaching of nitrogen from manure into surface and ground water. In addition, carbon dioxide emissions and removal from agriculture-related land use include liming of agricultural soils, conversion of grassland to cultivated land, and on-farm energy use (EPA, 2014).

Ruminant animals (e.g., cattle, buffalo, sheep, goats, and camels) are the major agricultural emitters of methane because microbial fermentation in the large “fore-stomach” breaks down the feed they consume. Non-ruminant animals (e.g., swine and equine) produce methane emissions through microbial fermentation in the large intestine; the amount produced is less on a per-animal mass basis than ruminants. Generally for all livestock, lower feed quality and/or higher feed intake leads to higher methane emissions (EPA, 2014).

For the purpose of making comparisons in this document, cattle were chosen because of their large contribution to agricultural GHG emissions. Due to the variability associated with estimating percentages at a given body weight, and lack of data on some species, the number of routine cattle mortalities was used instead of estimating the total of routine mortalities for all livestock species. In 2012, cattle were the largest emitters of methane; methane from manure management was calculated as 52.9 Tg CO_2 Eq., while direct and indirect nitrous oxide emissions from manure management were estimated at 18.0 Tg CO_2 Eq. (EPA, 2014). Based on 2012 laboratory data, annual methane emissions from burial of cattle mortalities in the

United States was calculated at 1.6 Tg CO_2 Eq., which represents less than 1 percent of the total emissions produced by the agricultural sector in 2009 (Yuan et al., 2012).

Animal deaths are inherent during animal production, and have the potential to create an impact on the overall agricultural contribution to GHG emissions. Animal deaths occur from predators, injuries, natural disasters, genetic issues, management considerations (including slaughter before maturity), disease, and other factors. When livestock die, an estimate of the number of these mortalities can be derived as part of the animal production statistics (NASS, 2011; NASS, 2012; NASS, 2013; NASS, 2014). In the aggregate, mortalities reduce short-term needs for feed production, feed consumption, and animal waste removal until the herd size is replenished. Animal feed production involves expenditures of fossil fuels during cultivation, harvesting, processing, and transport, as well as energy use during pesticide and fertilizer manufacture.

If it is assumed naturally decomposing carcasses are a biogenic source of GHGs simply because soil micro-organisms are degrading their biomass, then any or all GHG emissions from onsite burial, landfills, and composting would be irrelevant because they are not caused by humans. Any additional carcass management decomposition processes that use micro-organisms (e.g., anaerobic digestion and some rendering processes) could similarly claim to be biogenic rather than human-mediated, so incineration and open-air burning would become the only GHG-producing options. Although this concept would allow many simplifying assumptions, it does not appear to be helpful for making further comparisons among the carcass disposal options because GHG emissions are associated with all of the disposal options.

To make meaningful comparisons, APHIS assumes the total amount of carcass biomass becomes a single source of GHGs. APHIS considers this aggregate biomass by using the 50-ton threshold in this EIS as a source of known composition. Doing so allows APHIS to disregard specific disposal technologies, and estimate the potential level of GHG emissions from any mass mortality event to evaluate the relative contribution of these carcass management activities to agricultural GHG emissions.

A conversion of animal biomass to potential GHG emissions involves multiplication by a series of constants chosen to reflect various parameters on the processes. The calculations must convert to a common weight basis, account for the composition of the carcass (percent carbon and percent nitrogen in dry weight), convert the carbon in methane to carbon dioxide, convert the nitrogen into a GHG form (nitrous oxide), and account for the impact (Global Warming Potential or GWP) of these compounds. GWP is "an index used to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emission of one kilogram of a greenhouse gas to that from the emission of one kilogram of carbon dioxide over a fixed period of time, such as 100 years" (EIA, 2014).

APHIS made a further assumption about the fate of carbon and nitrogen for the purpose of these calculations. As a simplifying assumption to allow consideration of a theoretical maximum, APHIS' calculations assume all the carbon would be converted into methane rather than a mixture of carbon dioxide and methane, and APHIS assumes the fate of all nitrogen will be as nitrous oxide. While a very small portion of the total nitrogen excreted from an animal is expected to convert into nitrous oxide in a waste management system (EPA, 2014), and most nitrogen is expected to be degraded from animal proteins into nitrites and nitrates; these chemical forms are interconverted into all forms over time within the nitrogen cycle. The percent released as nitrous oxide during any of these conversions is not known, however, released nitrous oxide gas is long-lived in the environment, therefore calculations account for the impact of this form of nitrogen.

The number of dead mature cattle (not due to predators) was reported as 1,729,900 in 2013 (NASS, 2014). For comparison purposes, APHIS assumes each head of cattle is one-half ton (1,000 pounds) to account for deaths prior to the mature market weight average of 1,350 pounds (McMurray, 2009). This means roughly 865,000 tons of routine cattle mortalities occurred in 2003, compared to the 50 ton threshold level selected for this EIS. On a fresh weight or biomass basis, 1,000 mass mortality events are approximately 5.78 percent of the routine mortalities for cattle per year. (1,729,900)(.5 ton) = 864,950 tons; (1000)(50)/864,950 is 5.78 percent.

While the human body is generally recognized to be 18.5 percent carbon and 3.2 percent nitrogen (OpenStax College, 2013), the regression equations used to calculate data on cattle composition vary with the nutrition plan, breed, and sex of the animal (Krehbiel and Holland, 2009; Kuhla et al., 2004; Marcondes et al., 2012). For consistency and simplicity, APHIS' comparisons use the human body percentages. Cattle are reported to be 70 percent water (Kuhla et al., 2004). The conversion of carbon and nitrogen into GHG molecules is based on constants derived from their molecular weights (for carbon from methane into carbon dioxide (12+1+1+1+1)/12 = 1.33, and for nitrogen into nitrous oxide (14+14+16)/(14+14) = 1.57 (EPA, 2014)). The GWP for methane is 25, and for nitrous oxide it is 298 (Climate Change Connection, 2009).

(1) Routine carcass disposal carbon content to methane
(1,729,900 head)(1000 lbs/head)(4.54×10^{-10} teragrams/lb)(0.30 dry weight)(.185 C/dry weight)(1.33 carbon conversion)(25 GWP) = 1.45 Tg CO_2 Eq.

(2) Routine carcass disposal nitrogen content to nitrous oxide
(1,729,900 head)(1000 lbs/head)(4.54×10^{-10} teragrams/lb)(0.30 dry weight)(0.032 nitrogen/dry weight)(1.57 nitrogen conversion)(298 GWP) = 3.53 Tg CO_2 Eq.

(3) Carcass disposal from a 50-ton event C content to CH_4
(50 tons)(2000 lbs/ton)(4.54×10^{-10} teragrams/lb)(0.30 dry weight)(.185 C/dry weight)(1.33 C conversion)(25 GWP) = 0.0000838 Tg CO_2 Eq.

(4) Carcass disposal from a 50-ton event N content to N_2O
(50 tons)(2000 lbs/ton)(4.54×10^{-10} teragrams/lb)(0.30 dry weight)(0.032 N/dry weight)(1.57 N conversion)(298 GWP) = 0.000204 Tg CO_2 Eq.

For comparison purposes, APHIS calculated the routine cattle mortalities in 2013 had the potential to generate roughly 1.45 Tg CO_2 Eq. from the methane component, and 3.53 Tg CO_2 Eq. from an nitrous oxide component if the carbon and nitrogen have no other fate in the environment. APHIS also calculated a single 50-ton disposal event has the potential to generate roughly .0000838 Tg CO_2 Eq. from methane and .000204 Tg CO_2 Eq. from nitrous oxide, if the same assumptions are made. The calculated value used by APHIS for the methane component of routine mortalities is comparable to the 1.6 Tg CO_2 Eq. derived from laboratory data for carcass burial, and the assumption of 2.2 million routine cattle carcass mortalities (Yuan et al., 2012).

APHIS' calculated values for the methane components are a small fraction of the methane produced from manure management (EPA, 2014); (routine mortalities 1.45/52.9 Tg CO_2 Eq.< 3 percent, and for a 50-ton event 0.0000838/52.9 << 1 percent). This suggests the waste from living ruminant animals contributes a great deal more to GHG production than the decomposition of their carcasses. Conversion of all nitrogen from routine mortalities into nitrous oxide appears to have the potential to release about 20 percent of the direct and indirect nitrous oxide emissions from manure management (estimated at 18.0 Tg CO2 Eq., (EPA, 2014)), while a 50-ton event is estimated below 1 percent. A thousand 50-ton events (1000[0.0000838 + 0.000204] = 0.2878 Tg CO_2 Eq.) is estimated to be 5.47 percent of the 2012 estimate of 526.3 Tg CO_2 Eq. from the agricultural sector.

The total from a single 50-ton disposal event (0.0002878 Tg CO_2 Eq.) = 287.8 metric tons. Using the above assumptions and ignoring any GHG-generating energy inputs required for the disposal process, APHIS could conduct up to 86 carcass disposal programs per year before exceeding the 25,000 metric tons CO_2 Eq. threshold set by CEQ.

The volume of GHG released during carcass decomposition decreases when any disposal method recovers, reduces, captures, or converts GHGs into other chemical forms. Technology is available during landfill burials, incineration, and rendering to capture GHGs, and make them available for other uses. During burial, composting, and landfill disposal, metabolic activities of soil micro-organisms convert animal proteins into various chemical forms of nitrogen.

Table C–1 provides relative ratings for individual GHG emissions associated with the disposal methods. In this analysis, GHG contributions from transport are set mid-way in the rating scale (0=lowest; 5 = highest) because APHIS cannot determine the distances travelled, and onsite methods are assumed to use less mileage. APHIS assumes recapture/mediation technologies are present offsite, but none are available during onsite disposal. APHIS assumes synthetic plastic bioliners (Slingluff et al., 2014) must be used during offsite transport to reduce biosecurity risks to an acceptable level. The production of those liners is likely to be associated with GHG releases. The relative rankings in table C–1 can inform decisionmakers if/when they believe consideration of specific GHG emissions should be part of their analyses.

The timeframe for GHG release varies among the disposal methods because different methods require varying amounts of time for the carcass to decompose. The potential GHG release periods for onsite burial and offsite landfill may take 10 or more years, while composting is likely to take 2 to 3 years. Open-air burning, incineration, and rendering are estimated to take less than 0.1 years, therefore GHG emissions, should they occur, are likely to be spread over these time intervals.

Also during carcass disposal, human labor is supplemented by energy consumptive machinery which influences the GHG balance. This human labor by machine energy interaction appears greater for all offsite methods (incineration, rendering, and landfill) because of the need for transport and any energy needed to "prime" disposal machinery. Composting appears to involve more labor and machinery than burial or open-air burning because windrows require periodic turning.

Although rendering releases carbon dioxide when hydrogen is produced from the breakdown of glycerol, the industry considers the process carbon neutral with regard to GHG production. This position is based on the released carbon being previously absorbed during the creation of the organic matter rather than being sourced from fossilized fuels (Meeker, 2006).

Table C–1. Qualitative Estimates of GHG Emissions For Each Disposal Method (Using A Relative Rating Scale of 0=least to 5=highest).

Sources of Emissions	GHG Type	Onsite (release of GHGs without additional mitigation)			Offsite (fixed-location facilities with GHG recapture or mediation technologies)		
		Burial	Open-air Burning	Composting	Incineration	Rendering	Landfill
Vehicles and Equipment (fuel consumption)	CO_2	0	2	1	3	3	3
	CH_4	0	0	1	0	0	0
	NO_2	1	2	1	3	3	3
Decomposition or Processing	CO_2	4	5	3	2	1	3
	CH_4	4	4	3	0	0	2
	NO_2	5	5	3	2	0	1
Bioliners for transport (synthetic plastic) (Slingluff et al., 2014)	CO_2	n/a	n/a	n/a	1	1	1
	CH_4	n/a	n/a	n/a	0	0	0
	NO_2	n/a	n/a	n/a	2	2	2
Relative Ranking		3	5	2	1	0	4

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Appendix D. References for Appendices A, B, and C

CEQ—See Council on Environmental Quality

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Appendix E. Preparers

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Background: Environmental engineer with expertise in hazardous waste site remedial design and construction oversight, program management, permitting, environmental compliance, and animal health emergency decontamination and disposal research, development, and implementation guidance. More than 13 years of service with APHIS. Expertise in carcass management, biosecurity, environmental remediation, and environmental compliance.

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Appendix F. Review and Consultation

The following individuals have reviewed draft sections of this environmental impact statement (EIS) or were consulted on critical issues that have been addressed in this EIS. The expertise and concerns of these individuals were considered during the development of this EIS; the content of this EIS does not necessarily reflect their individual views and opinions.

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Appendix H. Acronyms and Glossary

A

Abiotic Resources	Physical rather than biological resources. In this document, abiotic resources include land, air, and water.
Adaptive Management	A systematic approach for improving resource management. It involves exploring alternative ways to meet management objectives, considering the potential outcomes from implementing the various alternatives, implementing a plan, monitoring outcomes, and adjusting future actions when necessary.
Agricultural Bioterrorism	The intentional release of toxic biological agents targeting livestock and crop resources.
AHPA	See Animal Health Protection Act
Air Curtain Incineration	A potential carcass management process that forces a curtain of air over the burn chamber of a firebox (a walled unit where the fire is enclosed) which ignites the carcass waste.
Air Quality Index (AQI)	A manner to report how polluted the air is in a given area. The higher the value, the greater the level of air pollution and the greater the health concern.
Alkaline Hydrolysis	A potential carcass management process that uses a base, typically sodium hydroxide or potassium hydroxide, to break chemical bonds within animal tissues by inserting water molecules. The process is further accelerated by applying heat and pressure.
Anaerobic Digestion	A series of chemical processes used to preserve carcasses under acidic conditions and then anaerobically (without oxygen) decompose the carcass.
Animal and Plant Health Inspection Service (APHIS)	An agency within the United States Department of Agriculture. APHIS protects and promotes U.S. agricultural health, regulates genetically engineered organisms, administers the Animal Welfare Act, and carries out wildlife damage management activities.
Animal Health Emergency	The sudden death of many animals within a small area during a short period of time.

Animal Health Protection Act (AHPA) Federal legislation that provides for the protection and welfare of animals.

Anthropogenic Of, relating to, or resulting from the influence of human beings on nature.

APHIS See Animal and Plant Health Inspection Service

AQI See Air Quality Index

B

Barbiturates Drugs that act as a depressant and can cause mild sedation to unconsciousness; can be used to euthanize livestock.

Baseline A starting point used for comparisons. For purposes of this EIS, the no action alternative is used as a baseline to compare potential environmental impacts among the alternatives.

Best Management Practices (BMPs) A collection of effective measures that provide protection of environmental resources during land management activities.

Biochemical Oxygen Demand (BOD) The amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material at a specific temperature and over a specific time period. BOD is used as an indicator of water quality.

Biofilter Layer A layer of live material used to capture and assist in degrading pollutants.

Biological Agent A bacterium, virus, protozoan, parasite, or fungus, as well as their associated toxins, which can be used purposefully as a weapon in bioterrorism.

Biomass The biological matter or the byproduct derived from a previously living animal.

Biotic resources Of, or relating to, living things. In this document, biotic resources refer mainly to animals and vegetation.

Biosecurity Procedures that are intended to protect humans and/or animals against viruses or other harmful agents.

BMPs See Best Management Practices

BOD See Biochemical Oxygen Demand

Bovine Spongiform Encephalopathy (BSE)	Bovine spongiform encephalopathy is a transmissible spongiform encephalopathy disease in cattle. BSE causes a spongy degeneration in the brain and spinal cord and is fatal.
BSE	See Bovine Spongiform Encephalopathy
Buffer Zone	An area of land that lies between two other areas of land. The middle area of land serves to provide distance between where an action is taking place that can potentially cause environmental impacts and an area that is being protected.
Byproduct	Material, other than the principal product, that is generated as a consequence of an industrial process.

C

CAA	See Clean Air Act
CAFO	See Concentrated Animal Feeding Operation
Captive Bolt	A gun that uses gunpowder or compressed air to propel a bolt into the brain of an animal, causing rapid unconsciousness and death.
Carcass	Bodies or body parts of dead animals including but not limited to livestock, wildlife, and companion animals.
Carcass Disposal	The act of getting rid of animal carcasses that are considered waste. For purposes of this document, carcass disposal includes carcass processing techniques. Carcass processing techniques do not actually get rid of the animal carcasses but break the carcasses down into components that may then be disposed.
Carcass Leachate	The bodily fluids that leak from the dead animal as well as the liquid that results from decomposition of the animal.
Carcass Management	The discovery, collection, transportation, disposal and/or processing of dead animals and body parts, and cleanup and decontamination
CDA	Colorado Department of Agriculture
CDC	Center for Disease Control
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations (U.S.)

Chronic Wasting Disease (CWD)	A neurological disease of hoofed-ruminant mammals, such as deer and elk.
Clean Air Act (CAA)	The Clean Air Act is a Federal law enforced by the EPA, designed to control air pollution.
Clean Water Act (CWA)	Clean Water Act is the primary Federal law in the United States governing water pollution.
Combustion Efficiency	The measurement of how well fuel is being burned.
Companion Animals	A pet or other domestic animal such as a cat or dog.
Composting	For purposes of this document, composting refers to the carcass management option in which the carcasses decompose in the presence of oxygen (or air) and organic matter. Composting relies on naturally occurring microbes, such as bacteria and fungi, to aid in the process.
Concentrated Animal Feeding Operation (CAFO)	An agricultural enterprise where animals are kept and raised in confined situations. CAFOs congregate livestock, feed, manure and urine, dead animals, and productions to a limited land area. Feed is brought to the livestock rather than livestock grazing or seeking food.
CWA	See Clean Water Act
CWD	See Chronic Wasting Disease

D

Decomposition	The process of rotting or decay
Decontamination	Inactivation or reduction of contaminants by physical, chemical, or other methods to meet a cleanup goal.
DHS	Department of Homeland Security
Dioxin	A highly toxic and persistent chemical. Incomplete carcass combustion can produce dioxins, which are carcinogens that can adversely affect human reproduction, development, and immune systems.
Dirty Bomb	A type of bomb which combines radioactive material with conventional explosives.

Disinfectant A pesticide product that kills or inactivates microorganisms on inanimate surfaces.

Disinfection To kill or inactivate micro-organisms on inanimate objects with a pesticide.

DOT U.S. Department of Transportation

E

EA See Environmental Assessment

Ecoregion A large unit of land or water with geographically distinct species, communities, and environmental conditions.

Environmental Assessment (EA) A concise public document which provides sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or Finding of No Significant Impact; an EA aids in compliance with the National Environmental Policy Act (NEPA) when no Environmental Impact Statement is needed.

Environmental Fate The life cycle of a chemical (e.g., a pesticide or other pollutant) after it is released into the environment. A chemical's environmental fate includes what a chemical may break down into and how quickly it breaks down.

EIS See Environmental Impact Statement

Environmental Impact Statement (EIS) A document prepared by a Federal agency in which anticipated environmental effects of alternative planned courses of action are evaluated; as required by section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA).

EPA U.S. Environmental Protection Agency

Euthanized Put to death humanely

Eutrophication Excessive richness of nutrients in a body of water which causes a dense growth of plant life. Subsequently, the dense growth of plant life can result in a reduction of oxygen and biodiversity of fish and invertebrates.

F

FAD See Foreign Animal Disease

Facultative Scavenger	Facultative describes organisms that are able to adopt an alternative mode of living; a facultative scavenger is a predator that can also scavenge for meals as a supplement to its diet.
FAO	See Food and Agriculture Organization
Farmland Protection Policy Act (FPPA)	The intent of the Farmland Protection Policy Act is to minimize the impact of Federal programs on the unnecessary and irreversible conversion of farmland to nonagricultural uses.
FDA	See U.S. Food and Drug Administration
Federal Emergency Management Agency (FEMA)	The Federal Emergency Management Agency is an agency of the U.S. Department of Homeland Security; the mission is to lead the United States in preparing for, preventing, and responding to and recover from disasters.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	An Act that provides Federal control over the distribution, sale, and use of pesticides.
FEMA	See Federal Emergency Management Agency
FIFRA	See Federal Insecticide, Fungicide, and Rodenticide Act
Fixed Incinerator	Incinerators, including small on-farm incinerators, small and large incineration facilities, crematories, and power plant incinerators, that are located at a permanent location.
FMD	See Foot-and-Mouth Disease
Food and Agriculture Organization (FAO)	An agency of the United Nations that leads international efforts to defeat world hunger.
Food and Drug Administration (FDA)	An agency within the United States Department of Health and Human Services. FDA is responsible for protecting public health through regulating such products as pharmaceutical drugs and cosmetics.
Food Safety Inspection Service	An agency of the U.S. Department of Agriculture

Foreign Animal Disease (FAD)	High-consequence diseases that are nonexistent in the United States or limited in distribution.
Foot-and-Mouth Disease (FMD)	Foot-and-mouth disease is a severe, highly contagious viral disease that causes illness in cows, pigs, sheep, goats, deer, and other animals with divided hooves. The disease can spread quickly and cause significant economic loss. FMD is not a public health or food safety threat.
FPPA	See Farmland Protection Policy Act
FSIS	See Food Safety Inspection Service
FWS	Fish and Wildlife Service; an agency of the U.S. Department of the Interior

G

Gasification	Process by which solid and liquid waste materials are sent through a primary gas chamber, followed by a secondary combustion chamber, and converted to a gas product. This process is provided in this document as an example of a potential adaptive management alternative.
GDP	See Gross Domestic Product
GHGs	See Greenhouse Gases
Global Warming Potential (GWP)	Global warming potential is an index that was developed to allow comparisons of the global warming impacts of different gases. It is a measure of how much energy the emissions of one ton of a gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide. The larger the GWP, the more that a given gas warms the Earth compared to carbon dioxide over that time period.
Granivorous Birds	Birds that feed on grains.
Greenhouse Houses (GHGs)	Gases that contribute to global warming by trapping the sun’s radiation in the earth’s lower atmosphere. Examples of GHGs include carbon dioxide, methane, and nitrous oxide.
Gross Domestic Product (GDP)	The total monetary value of goods produced and services provided in a country during 1 year.

Ground Water The supply of freshwater found beneath the Earth's surface (usually in aquifers), which often supplies drinking wells and springs. Because ground water is a major source of drinking water, there is growing concern over areas where leaching agricultural or industrial pollutants or substances from leaking underground tanks are contaminating ground water.

GWP See Global Warming Potential

H

Half-life The time necessary for the concentration of a chemical to decrease by 50 percent; a measure of the persistence of a chemical in a given medium (the greater the half-life, the more persistent a chemical is likely to be).

HHS U.S. Department of Health and Human Services

HMTA Hazardous Materials Transportation Act

Humus The dark brown to black organic material in soils, produced by the decomposition of vegetable or animal matter.

I

IDAPA Idaho Administrative Procedures Act

IFAP See Industrial Farm Animal Production

Incineration For purposes of this document, incineration is a carcass management option that ignites waste materials.

Industrial Farm Animal Production (IFAP) Industrial farm animal productions are large farming operations used for growing food animals.

Improvised Nuclear Device An illegal crude device that incorporates and disperses radioactive materials. The device may be either fabricated by a terrorist group from illegally obtained materials, or the weapon may be bought or stolen from a nuclear state.

Inputs In this document, inputs are primarily referring to resources that are required for a carcass management option.

L

Lactic Acid Fermentation An anaerobic (without oxygen) process that transforms sugars into lactic acid using bacteria.

Landfills Highly regulated engineered structures that contain solid wastes. For purposes of this EIS, landfills are a carcass management option.

Leachate Primarily referring to the liquid that results from the decomposition of livestock carcasses, including the body fluids that leak from the dead animal.

Livestock All farm-raised animals including poultry.

M

Mass Animal Health Emergency A natural disaster or chemical, biological, and/or radiological event generating 50 tons of carcasses or more.

Mass Carcass Management The management of 50 tons (100,000 pounds) or more of biomass per premises (where livestock are housed or kept); the discovery, collection, transportation, disposal and/or processing of 50 tons (100,000 pounds) of dead animals and body parts, cleanup and decontamination.

Micro-organism Living organisms, usually so small that individually they only can be seen through a microscope.

Microwave Sterilization Water, high temperatures, and pressure sterilize carcasses using multiple high energy microwave generators.

Mobile Incinerators Incinerators that can be transported to the site of the emergency.

Mycotoxin Any toxic substance produced by a fungus.

N

NAAQS See National Ambient Air Quality Standards

NAGPRA See Native American Graves Protection and Repatriation Act of 1990

NASS See National Agricultural Statistics Service; a unit within USDA

National Agricultural Statistics Service (NASS)	Provides statistics regarding U.S. agriculture.
National Ambient Air Quality Standards (NAAQS)	Standards established by EPA under the Clean Air Act. The standards provide protection to public health, including "sensitive" populations such as asthmatics, children, and the elderly. The standards also provide protection against decreased visibility and damage to animals, crops, vegetation, and buildings.
National Pollution Discharge Elimination System (NPDES) Permits	Permits granted by EPA or individual States that control regulated point source discharge into waters of the United States.
Native American Graves Protection And Repatriation Act of 1990 (NAGPRA)	The Native American Graves Protectoin and Repatriation Act of 1990 describes the rights of Native American lineal descendants, Indian tribes, and Native Hawaiian organizations with respect to the treatment, repatriation, and disposition of Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony (i.e., cultural items).
NEPA	The National Environmental Policy Act of 1969 and subsequent amendments.
NIMS	National Incident Management System
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
Nonstandard Disposal Options	Carcass management options that are not normally used but may become more effective, economical, or available in the future.
NPDES Permits	See National Pollution Discharge Elimination System Permits
Nuclear Incident	An event that involves the detonation of a nuclear device.

O

OIE	Office of International des Epizooties or World Organization for Animal Health

Open-Air Burning For purposes of this EIS, refers to placing carcasses on combustible heaps in an open field and burning them to ash.

Outputs For purposes of this EIS, outputs refer to the byproducts of a carcass management option.

P

Pathogen A bacterium, virus, or other micro-organism that can cause disease.

Polyvinyl chloride (PVC) A widely produced synthetic plastic polymer. PVC may be used as an impermeable barriers that is placed between the ground and compost piles to help contain leachate.

Premises For purposes of this EIS, premises are locations where livestock are housed or kept and where an animal health emergency may occur.

Prions A small proteinaceous (of or relating to a protein) infectious, disease-causing agent. It is neither bacterial, fungal, nor viral and contains no genetic material. Prions are responsible for a number of degenerative brain diseases known as transmissible spongiform encephalopathy (TSE) such as variant Creutzfeldt-Jakob disease in humans, bovine spongiform encephalopathy (BSE) in cattle, and scrapie in sheep.

Pyre A heap of combustible material. In this document, specifically referring to a heap of carcasses to be burned.

PVC See Polyvinyl Chloride

R

Radiological Agents Material that emits ionizing radiation when they decay.

Radiological Incident An event in which radiation was produced without the detonation of a nuclear device.

Radionuclides Radioactive particles

Raptors Birds of prey such as eagles, hawks, falcons, and owls.

RCRA See Resource Conservation and Recovery Act of 1976

Rendering For the purposes of this document, is a physical and chemical transformation of carcasses using a variety of equipment and processes that require heat, extraction of moisture, and the separation of fat.

Resource Conservation and Recovery Act of 1976 (RCRA)	An Act established to create standards for the generation, treatment, storage, and disposal of wastes. The Act essentially banned open dumps. EPA is responsible for compliance monitoring and enforcement activities under RCRA.
Rivers and Harbors Act of 1899	An Act makes it a misdemeanor to discharge waste into navigable waters or tributaries of the United States without a permit.
Ruminants	Even-toed, hoofed animals of the suborder Ruminantia.

S

Scrubbers	An odor and pollution control technology that removes certain gases and particulates from exhaust.
Setback	The legal minimum distance needed between a building site (or, in the case of this EIS, carcass disposal sites) and surrounding site(s) needing protection, such as water bodies, property lines, or even potential nuisances.
SOPs	Standard operating procedures
Soil Amendment	A product that can be added to the soil to improve its physical qualities and aid in nutrient availability for plants.

T

T&E Species	See Threatened and Endangered Species
Tallow	Animal fat; one of the three major products of rendering carcasses.
Threatened and Endangered Species (T&E Species)	Threatened species are any species listed in the Federal Register that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range; endangered species are any species that are in danger of extinction throughout all or a significant portion of its range.
Total Dissolved Solids	A measure of inorganic and organic substances suspended in a liquid; the measurement is used as an indicator of the presence of chemical contaminants.

Transmissible spongiform encephalopathy (TSE)
Diseases, thought to be caused by the presence of a misfolded protein (prion) in the animal's nervous tissue, cause slow degeneration of the nervous system, ultimately ending in death. TSE in sheep and goats is referred to as scrapie, mad cow disease or bovine spongiform encephalopathy (BSE) in cattle, chronic wasting disease (CWD) in deer and elk, and variant Creutzfeld-Jakob disease (vCJD) in humans.

Transportation Corridor
For purposes of this EIS, the route that carcasses, contaminated material, and equipment travel between the carcass discovery site and the final carcass management destination.

Trench
For purposes of this EIS, a trench is a long, narrow ditch used to bury carcasses.

TSE
See Transmissible Spongiform Encephalopathy

U

Unlined Burial
For purposes of this EIS, unlined burial is referring to when carcasses are placed in a pit or trench with no lining for purposes of disposal.

USACOE
U.S. Army Corps of Engineers

V

Variant Creutzfeldt-Jakob Disease (vCJD)
vCJD is a rare, degenerative, fatal brain disorder in humans caused by prions.

vCJD
See variant Creutzfeldt-Jakob Disease

Vermin
Small, common, harmful animals that are difficult to control. Examples include insects and rodents.

Veterinary Services (VS)
VS is a program unit with USDA–APHIS that works to protect and improve the health, quality, and marketability of U.S. animals, animal products and veterinary biologics.

VOC
See Volatile Organic Compound

Volatile Organic Compound (VOC)
A VOC is a gas emitted from certain solids or liquids, such as paints, cleaning supplies, pesticides, and building materials. Some VOCs may have short- and long-term adverse human health effects.

VS See Veterinary Services

W

Windrow Composting A method of composting that piles the organic matter and waste in long rows.

Z

Zoonoses A disease that can be transmitted from animals to humans.

Appendix I. Index